DMM4020/DMM4021

LABORATORIES INC.
1800 De la Cruz Ave. Santa Clara, CA 95050 (408) 727-3286

Operating Manual

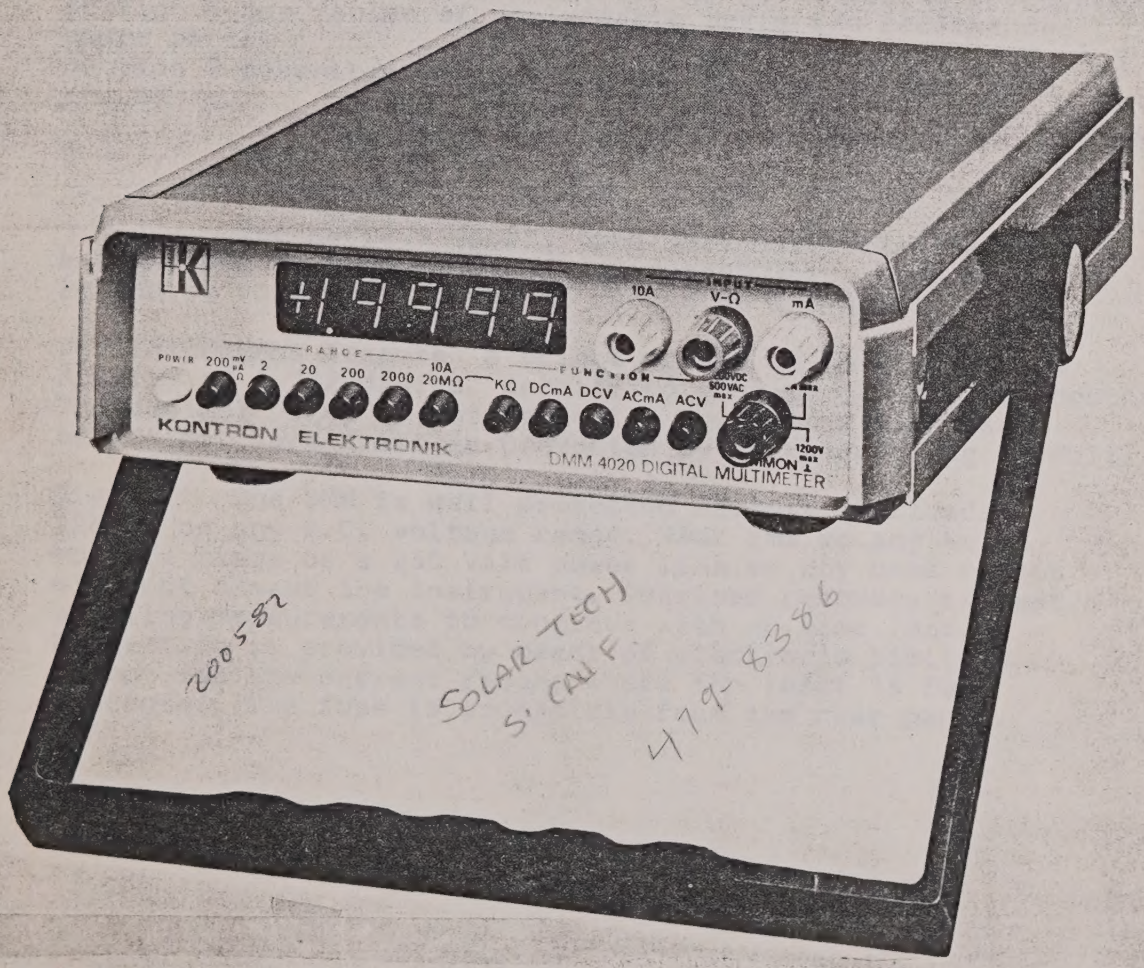
Multimeters

KONTRON

Multimeters

MP MASTER
MA35127

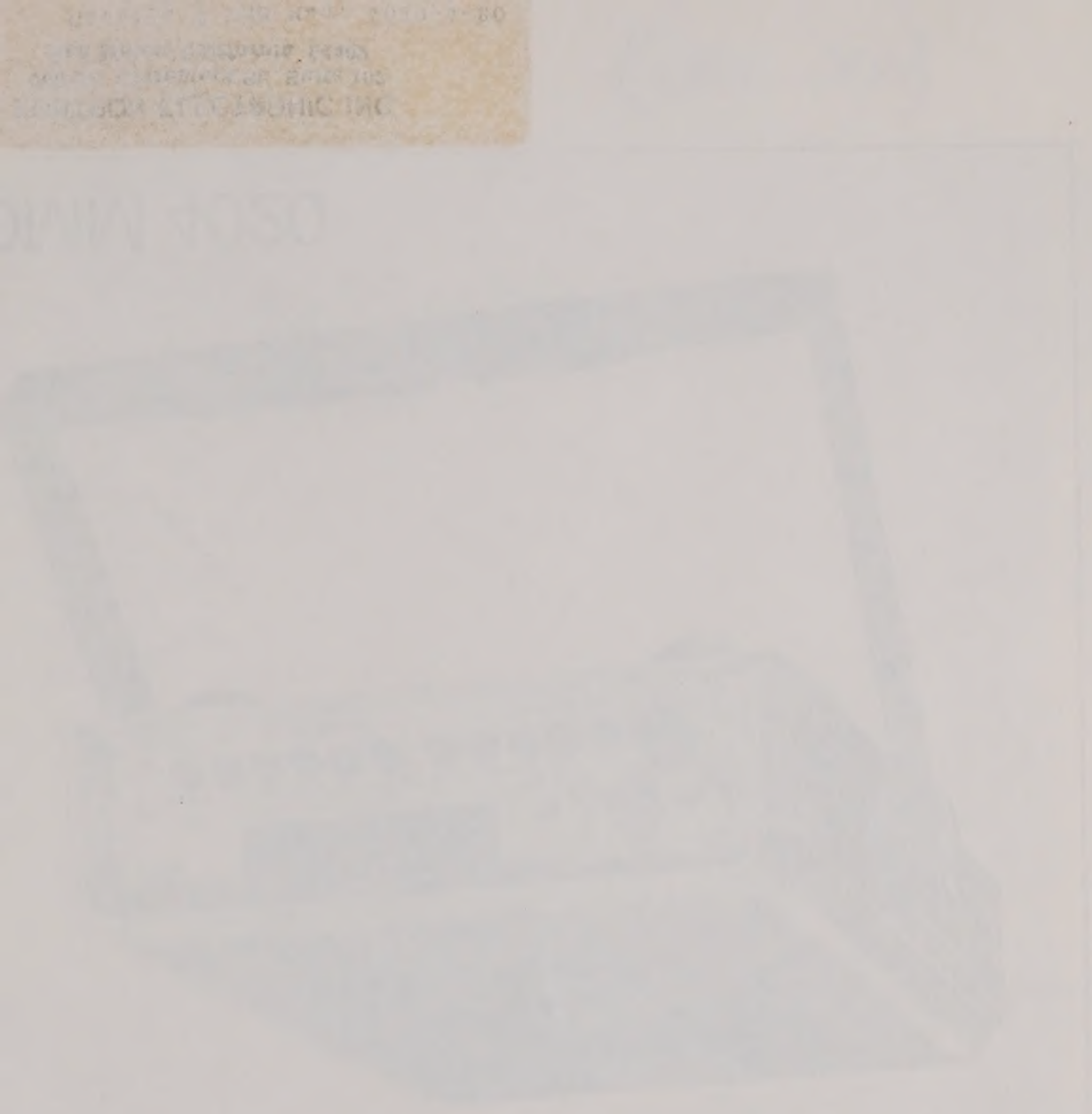
Instruction Manual



DMM 4020

KONTRON ELECTRONIC INC.
700 So. Claremont St., Suite 107
San Mateo, California 94402

Catalog # DMM-Man. 4020-4-80



SECTION 1

GENERAL INFORMATION

1 - 1. INTRODUCTION

1 - 2. This manual provides operation and maintenance for the Kontron Models 4o2o and 4o21 Digital-Multimeters.
Section 1 is a general description of the Models 4o2o/4o21.
Section 2 and 3 contain installation and operation instructions.
The theory of operation is described in Section 4.
Section 5 outlines maintenance and troubleshooting procedures.
Section 6 has tables of replaceable parts and recommended spare parts.
Section 7 describes the options which are available with the DMM's.

1 - 3. DESCRIPTION

1 - 4. The KONTRON Models 4o2o/4o21 Multimeters are a 4 1/2 digit, five function instrument which measures ac and dc voltages, ac and dc currents, and ohms.

The instrumens feature a bright orange 11 mm (o.43") LED display of 4 1/2 digits, permitting plus or minus 19999 counts. The decimal point is automatically positioned with range selection. Zero drift is prevented by an autozeroing circuit.

1 - 5. The DMM is well protected against overloads. 12oo V on any D.C. voltage range, 75oV rms on any ac voltage range or a 250 Volt power line on any ohms ranges will not damage the instrument. Overload recovery is fast, enabling measurements to continue with no time loss. Protection is provided by means of electronic limiters except for the current ranges where the input is fuse protected. The fuse is accessible from the rear panel.

1 - 6. Models 4o2o/4o21 feature a built-in batteries condition and display tests. Pushing simultaneously DCV and DCmA will light all segments on the display for a quick check of all seven segments. Pushing DCV and 2o MΩ range will provide the internal batteries check.

1 - 7. Model 4o21 features a unique test and calibration circuit. A built-in calibrator using a well tested and aged reference source provides a stable source for a quick accuracy check and complete field recalibration with no additional test equipment. Following easy steps which are printed on the bottom cover, one can calibrate or check the basic accuracy of all Functions, check for proper operation of the display and the condition of the internal batteries. Only three trimmers are being used to calibrate the entire instrument in all functions and ranges. Ultra stable, field proven matched fixed resistors eliminate the need for calibration of the upper ranges.

1 - 8. Models 4o2o/4o21 may be operated either from a 230/115 Vac source or internal rechargeable batteries. The built-in charger provides full charge with Power switch off and the instrument connected to power line, or trickle charge with the power switch on. The unit may be operated from the ac source with or without batteries installed.

1 - 9. The instruments are housed in a rugged and attractive metal case, are small and light enough to be easily carried. Quality components and reliable design techniques are used throughout to assure high reliability and low power consumption. A single circuit board is used for reliability and quick simplified service.

1 - 1o. SPECIFICATIONS

1 - 11. Specifications are listed in Tables 1-1 and 1-2. These specifications are the performance standards and/or limits to which the instrument can be tested.

Table 1-1. 4o2o Specifications

DC VOLTAGE	
Range :	± 2oo mv, ± 2v, ± 2ov, ± 2oov, ± 12oov
Accuracy: 1 year (15°C to 35°C)	± (o.o2% of reading + 1 LSD)
Input Impedence:	1o MΩ all ranges
Input Type :	Floating 12oo v max common to ground
Normal Mode Rejection:	Greater than 6o dB 5o Hz, 6o Hz
Common Mode Rejection:	Greater than 12o dB 5o Hz, 6o Hz (with 1K in either lead)
Temperature Coefficient: (0-15°C and 35-5o°C)	
2oo mv and 2 v ranges	± (o.oo1% of reading+o.ooo5% of range)/°C
2oo v to 12oo v ranges	±(o.oo3% of reading-o.oo1% of range)/°C
Zero Stability:	Auto zeroed on all ranges
Polarity:	Automatic bipolar '+' or '-' display
Overload:	± 12oo dc or 17oov p-p ac applied continuously to any range.
Response Time:	1 second maximum to rated accuracy.
AC VOLTAGE	
Ranges:	2oomV, 2V, 2oV, 2ooV, 75oV
Response:	AC true RMS responding
Crest Factor:	4:1 at full scale
Accuracy: 1 year (15°C to 35°C)	
2oomv to 2oov Ranges (above 1o% of Full Scale)	3oHz-5oHz; ±(1% of reading +o.1% of range) 5oHz-1ooHz; ±(o.5% of reading+o.1% of range) 1ooHz-1oKHz; ±(o.2% of reading+o.o5% ") 1oKHz-2oKHz; ±(o.5% of reading+o.1% ")
750V range (above 1o% of Full Scale)	3oHz-5oHz; ±(1% of raeding+o.1% of range) 5oHz-1ooHz; ±(o.5% of reading+o.1% ") 1ooHz-1KHz; ±(o.2% of reding+o.o5% ")
Temperature Coefficient: (0-15°C and 35-50°C)	
All Ranges:	± (.o1% of reading + .oo5% of range)/°C

Table 1-1. 4o2o SPECIFICATIONS(Continued)

Input Impedence:	1 MΩ shunted by less than 1oopF
Input Type:	Floating 12oov max common to ground
Response Time:	3 seconds max to rated accuracy
Overload:	75o VRMS, 1oooV peak ac applied continuously to any range-not to exceed 1 x $1o^7$ VHz product.

DC CURRENT

Ranges:	2ooμA, 2mA, 2omA, 2oomA, 2ooomA and 1oA
Accuracy: 1 year(15°Cto35°C) all ranges	±(o.1% of reading + o.o1% of range)
Input Type:	Floating 12oov max common to ground
Temperature Coefficient: (0-15°C and 35-50°C)	±(o.oo3% of reading + o.oo1% of range)/°C
Overload: (2oomA to 2ooomA)ranges	Protected to 2A on all ranges, fused above 2A.
1oA range	Not protected above 15A
Response Time:	1 second max to rated accuracy

AC CURRENT

Ranges:	2ooμA, 2mA, 2omA, 2oomA, 2ooomA and 1o A
Accuracy: 1 year(15°C to35°C) all ranges (above 10% of Full Scale)	3oHz-1ooHz± (1% of reading + o.1% of range) 1ooHz-5 KHz± (o.3%of reading+o.1% of range)
Temperature Coefficient: all ranges	±(o.o15% of reading+ o.oo5% of range)/°C
Overload: 2ooμA to 2ooomA ranges	Protected to 2A on all ranges, fuxed above 2A
10 A range	Not protected above 15A
Response:	True RMS
Crest Factor:	4:1 at full scale
Response Time:	3 second max to rated accuracy.

Table 1-1. 4o2o SPECIFICATIONS (Continued)

RESISTANCE

Ranges: 2oo Ω, 2 KΩ, 2o KΩ, 2ooKΩ, 2oooKΩ, 2oMΩ

Accuracy: 1 year (15°C to 35°C)

2oo Ω to 2oooK Ω	± (o.o5% of reading + o.o1% of range)
2o MΩ	± (o.1% of reading + o.o1% of range)

Temperature Coefficient:
all ranges ± (o.oo5% of reading + o.oo1% of range)/°C

Maximum open Circuit Volt. 5,5 volts

Overload Protection: 25oV rms or ± 250v dc, applied continuously.

Response Time:

2oo Ω to 2oooK Ω	1 second max to rated accuracy.
2o MΩ	3 seconds max to rated accuracy.

Current Through Unknown:

Range	2oo Ω	2 KΩ	2oKΩ	2ooKΩ	2oooKΩ	2oMΩ
Current	1 mA	1 mA	1ooμA	1oμA	1μA	1oonA
F.S.Volts	2oomV	2 V	2 V	2 V	2 V	2 V

Diode Test: On the 2 KΩ Range the current through the diode is 1mA and F.S. of 2 Volts. Reading on the display is the forward Voltage drop on the diode.

GENERAL

Display: Seven-segments LED.43" character height. Automatic decimal point and polarity Indicators.

Overrang Indication: Flashing display

Reading Rate: 3 per second

Maximum Common Mode Voltage 12ooV (DC + peak ac)

Operating Temperature: -10°C to 55°C

Humidity Range: 0 to 80% Rh

Table 1-1. 4o2o SPECIFICATIONS (Continued)

Power Requirement:	115/230VAC ± 15% 50 to 400Hz, 5 watt approx. or built-in 4 Ni Cad Rechargeable c cell batteries
Battery Operation:	5 hours typical
Battery Charge Time:	14 hours maximum
Dimensions:	Height - 68 m"m Width - 215 m"m Depth - 300 m"m
Weight:	2,2 Kg with batteries 2,85 Kg

SUPPLIED ACCESSORIES

The Model 4020 is supplied with ac power cable, testleads and instruction manual.

Table 1-2. 4021 SPECIFICATIONS

DC VOLTAGE	
Ranges:	± 2ooomV, ±2V, ± 20V, ± 200V, ± 1200V
Accuracy: (1 year 15°C -35°C)	± (o.o5% of reading + 1 LSD)
Input Impedence:	10 MΩ all ranges
Input Type:	Floating 1200V max common to ground
Normal Mode Rejection:	Greater than 6o db 5o Hz and 6o Hz
Common Mode Rejection:	Greater than 120 db 5o Hz and 6o Hz (With 1 K imbalance in either lead)
Temperature Coefficient: (0-15°C and 35-50°C)	± (o.oo3% of reading + o.oo1% of range)/°C
Zero Stability:	Auto zeroed on all ranges
Polarity:	Automatic bipolar '+' or '-' display
Overload:	±1200V dc or 1700V peak ac applied continuously to any range
Response Time:	1 second max to rated accuracy.
AC VOLTAGE	
Ranges:	2ooomV, 2V, 20V, 200V, 750V
Response:	True RMS
Crest Factor:	4:1 at full scale
Accuracy: 1 year(15°C-35°C) (above 10% of Full Scale)	
2ooomV to 2ooV ranges	± (1% of reading + o.1% of range) 45 - 1oo Hz ± (o.6% of reading + o.1% of range) 1oo - 1oKHz ± (1% of reading + o.1% of range) 1oKHz- 20KHz
750V range	± (o.6% of reading + o.1% of range) 45 Hz- 5 KHz
Temperature Coefficient (0-15°C and 35-5o°C)	± (o.o3% of reading + 0.o1% of range)/°C
Input Impedence:	1 MΩ shunted by less than 5o pF, all ranges
Input Type:	Floating, 1200V max common to ground
Response Time:	3 seconds max to rated accuracy

Table 1-2. 4021 SPECIFICATIONS (Continued)

Overload:	750V RMS or 1000V peak ac applied continuously to any range - not to exceed 1 x 10^7 VHz product.

DC Current

Ranges:	± 200µA, ±2mA, ±20mA, ±200mA, ±2000mA, ± 10A
Accuracy: 1 year(15°C-35°C)	± (0.3% of reading + 0.05% of range)
Input Type:	Floating, 1200V max common to ground
Temperature Coefficient: (0-15°C and 35-50°C)	± (0.015% of reading + 0.005% of range)/°C
Overload Protection 200 µA - 2000mA	Protected to 2A on all ranges, fused above 2A
10A	Not protected above 15A
Response Time:	1 second max to rated accuracy.

AC Current

Ranges:	200µA, 2mA, 20mA,200mA, 2000mA, 10A
Accuracy:°C 1 year(15 °C-35°C) (above10% of Full Scale)	± (1% of reading + 0.1% of range) 45 Hz to 5KHz
Input Type:	Floating, 1200V max common to ground
Response:	True RMS
Crest Factor:	4:1 Full Scale
Temperature Coefficient (0-15°C and 35 -50°C)	± (0.015% of reading + 0.005% of range)/°C
Overload Protection 200µA - 2000mA	Protected to 2A on all ranges, fused above 2A
10A	Not protected above 15A
Response Time:	3 seconds max to rated accuracy.

Table 1-2. 4021 SPECIFICATIONS (Continued)

Power Requirement :	115/230 VAC 15% 50 to 4oo Hz, 5 watt approx. or built-in 4 Ni Cad Rechargeable c cell batteries.
Battery Operation:	5 hours typical
Battery Charge Time:	14 hours maximum
Dimensions:	Height - 68 m"m Width - 215 m"m Depth - 300 m"m
Weight:	2,2 Kg with batteries 2.85 Kg

SUPPLIED ACCESSORIES

The Model 4021 is supplied with ac power cable, testleads and instruction manual.

Table 1-2. 4021 SPECIFICATIONS (Continued)

RESISTANCE

Ranges: 200Ω, 2 KΩ, 20KΩ, 200KΩ, 2000KΩ , 20MΩ

Accuracy:
1 year
(15°C -35°C) ± (o.1% of reading + o.o1% of range)

Temperature
Coefficient
(o-15°C and
35-5o°C) ± (o.o15% of reading + o.oo5% of range)/°C

Maximum Open
Circuit Voltage: 5,5 Volts

Overlaod
Protection : 250V rms or ± 250 Vdc applied continuously

Response Time:
200Ω to 2000KΩ 1 second max to rated accuracy
20 MΩ 3 seconds max to rated accuracy

Current Through Unknown:

Range	200Ω	2KΩ	20KΩ	200KΩ	2000KΩ	20MΩ
Current	1mA	1mA	1ooµA	1oµA	1µA	1oonA
F.S. Volts	200mV	2V	2V	2V	2V	2V

Diode Test: On the 2 KΩ range the current through the diode is 1mA and Full Scale of 2 Volts. Reading on the display is the forward voltage drop on the diode.

GENERAL

Display: Seven-Segments LED.43" character height. Automatic decimal point and polarity Indicators.

Overrange Indication: Flashing display

Readings Rate: 3 per second.

Maximum Common
Mode Voltage: 1200V (DC + peak ac)

Operating Temperature: -10°C to 55°C

Humidity Range: 0 to 80% Rh

1-12. OPTIONS

1-13. Several options are available for the Model 4020/4021. These options are listed in Table 1-1. Desired options may be specified at time of purchase. Contact your KONTRON representative for information which option must be factory installable. Refer to section 8 for specifications and operating information.

Table 1-4. OPTIONS

Option	DESCRIPTION	Factory installed	Field installable
-B	Internal Rechargeable battery pack	yes	yes
-C	Parallel BCD-Printer Output	yes	yes
-HP	Hold Probe	yes	no

SECTION 2

I N S T A L L A T I O N

2-1. INTRODUCTION

2-2. This section outlines inspection and initial installation procedure. Details are provided for power connection, grounding, safety requirements and packing instructions for storage or shipment.

2-3. UNPACKING AND RECEIVING INSPECTION

2-4. Examine the shipping carton for damage before unpacking the instrument. Carefully remove the instrument from the carton. Check immediately for loose or broken control knobs, bent or broken connectors and damage to any cabinet part. If damage of any nature is found, refer to the warranty instructions.

2-5. POWER LINE OPERATION

2-6. The 4020/4021 are designed to operate either from a 115 vac or 230 vac power source, or batteries. The primary voltage selection is made by positioning a recessed slide switch on the rear panel. To change the position of the slide switch, insert a small screwdriver in the switch slot and set the switch to the required voltage position. Damage caused by using incorrect primary input voltage voids the instrument warranty.

WARNING

The instrument is provided with a three-conductor power cord which will ground the case when connected to a three-connector grounding outlet. If a grounding outlet is not available, an adapter must be used which provides a good grounding connection.

2-7. BATTERY OERPATION

2-8. The instrument may be operated from rechargeable nickel-cadmium batteries. The battery charger is standard and factory installed.

2-9. Should batteries be installed or replaced, remove the two rear frame screws, remove the rear frame and slide out the top cover. Proper polarity of individual cells should be observed.

2-10. Charge condition of internal batteries can be checked by removing ac power line and by pushing simultaneously to 20 Megohm and DCV push-buttons. Display reading should be above 5 volts or the batteries must be charged.
Full charge will be obtained by applying ac power in the power off position for 14 hours.

2-11. As stated above, the 4020/4021 may be operated either from 230/115 vac or internal batteries. The built-in charger provides full charge with power switch off and instrument connected to the power line, or trickle-charged with power switch on. The instrument may be operated from the ac source with or without batteries installed.

2.12- PERFORMANCE CHECK

2-13. This instrument was carefully inspected for mechanical and electrical performance before shipment from factory. This unit should be free of physical defects and should comply with all electrical specifications upon receipt . Check the instrument for possible damage incurred in transit and refer to the performance check outlined in paragraphs 5-13 through 5-19 .
If there is any indication of damage or improper operation, refer to the warranty included in this manual.

2-14. ENVIRONMENTAL REQUIREMENTS

2-15. In order for the instrument to meet the specifications listed in Table 1-1, the operation temperature should be within the range of $-10^{o}C$ to $+ 50^{o}C$.

WARNING

To prevent potential electrical hazard, do not expose instrument to rain or moisture.

2-15. MOUNTING

2-16. The instrument case is provided with a carry handle which also serves as a tilt-stand. To change the position ot the handle, pull out both sides of the handle outward with the case to disengage the detent mechanism. Rotate the handle to the desired position and push the handle back towards the case, until it detents in place. Outline dimensions are shown in Figure 2-1.

2.-17. REPACKING FOR SHIPMENT OR STORAGE

2-18. The Models 4020/4021 are rugged instruments built to perform in severe environments. If the unit is to be shipped or stored for long periods of time the following packing procedure is recommended:

a) Rotate the carry handle until it faces forward and protects the front panel. Coil the power cord and place the coil into the rear panel. It may be desirable to tie the cord and/or put into a snug fitting plastic bag.

b) Place the instrument into an oversize plastic bag and seal the bag.

c) Place the bagged instrument into a heavy duty corrugated cardboard box. The box must contain at least two inches of rubberized hair or equivalent cushion on all six sides of the instrument. The instrument must fit snugly into the cushion and the cushion must fit into the box to prevent any movement of the instrument in transit.

d) Place the instruction manual into the box. If accessories are also to be packed put them into a separate plastic bag and pack into the cushion leaving at least two inches of cushion between the instrument and the accessories as well as an extra cushion between accessories and the box.

e) Seal the box fully with 2 or 3 inch wide packing tape.

f) Properly label and address outside of the box with a taped label or an indelible pen. Mark the box Fragile, Delicate Instrument, Handle with Care.

If shipment is to the factory, please notify in advance and include detailed reasons for return inside the box along with your name, firm and full mailing address. Also include your phone number and purchase order number.

SECTION 3

O P E R A T I O N

3-1. INTRODUCTION

3-2. This section will familiarize the operator with the typical operating procedures of the instrument. The front and rear panel controls, connectors and indicators are described.

3-3. CONTROLS, CONNECTORS AND INDICATORS

3-4. Figure 3-1. shows the instrument's front panel and Table 3-1 describes the functions. These descriptions are not intended to be operating instructions but, briefly, to familiarize the operator with the instrument.

Table 3-1. CONTROLS, INDICATORS AND CONNECTORS

Index No.	Controls, Indicators or Connectors	DESCRIPTION
1	POWER Switch	Switches instrument power ON or OFF. Power is ON when the pushbotton is depressed.
2	Display	Digital readout, 5 sections. Four seven-segment LED's and 1, plus a polarity indicator.
3	RANGE Switches	Select one of five voltage ranges and one of six current or resistance ranges.
4	FUNCTION Switches	Select one of five measurement functions: ACV, DCV, DCmA, ACmA and Kohm
5	VOLT-OHM Input Terminals	Used in conjunction with the COMMON terminal for measuring ac voltage, dc voltage or ohms.
6	mA or 10A Input Terminals	Used in conjunction with the COMMON terminal for measuring ac or dc current.
7	Fuse	Protects primary power circuits against accidental overload.
8	LINE SELECTOR Switch	Selects voltage for 115 vac or 230 vac operation.
9	AC Power Receptacle	Connects primary power to instrument.
10	Fuse	Used for current input protection.
11	Printer Output	Used for connection to printer.

Table 3-2. DMM's MAXIMUM ALLOWABLE INPUT OVERLOAD CONDITIONS

SELECTED FUNCTION	SELECTED RANGE	MEASUREMENT INPUT CONNECTION	MAXIMUM INPUT OVERLOAD LIMITS
DCV	200mV,2, 20, 200, or 2000 V	V- and COMMON	1200V dc or 1200V rms (sinusoidal)
ACV	200mV, 2, 20, 200, or 2000 V	V- and COMMON	750V rms (sinusoidal) not to exceed 10^7 V-Hz
DCmA,ACmA	200μ, 2, 20, 200,or 2000mA	mA and COMMON	2A(Fuse Protected)
DCmA, ACmA	10A	10A and COMMON	15A (Not protected above 15A)
K Ω	200 , 2, 20,200, 2000K	V- and COMMON	250V rms
Any	Any	Earth Ground and COMMON	1200V peak

3-5. OPERATING INSTRUCTIONS

3-6. Figures 3-2 through 3-8 outline instructions for making measurements with the Models 4020/4021. Each figure discusses a particular mode of operation. The number associated with each control indicate the step in which the control is being used.

1. Set POWER switch to ON.

2. Set FUNCTION switch to DCV.

3. Set RANGE switch to 2000 or the desired lower range if known.

4. Connect unknown DC Voltage across V and COMMON terminals. Reduce range until proper reading is reached.

5. Read voltage on display. Decimal point is correct positioned.

NOTE

A flashing display indicates overload. Switch the appropriate range switch to the next higher range until a steady display appears.

Unit may be used up to 30% overrange on all ranges but not to exceed 1200V. For example, 230V would be displayed as 3o.00 on the 200V range with a flashing display.

CAUTION

The measurement circuit is floated from the enclosure ground of the instrument. The potential applied between COMMON and ground must not exceed 1200V dc or ac or damage to the instrument may result.

Figure 3-2. DC Voltage Measurements.

1. Set POWER switch to ON.

2. Set FUNCTION switch to ACV.

3. Set RANGE switch to 2000 or the desired lower range if known.

4. Connect unknown AC voltage across V - and COMMON terminals.
   Reduce range switch until proper reading is reached.

5. Read voltage on display. Decimal point is correctly positioned.

CAUTION

Maximum allowable input voltage is frequency dependent. Do not exceed 10^7 V-Hz product.

NOTE

A flashing display indicates overload. Switch the appropriate range switch to the next higher ranges until a steady display appears.

Figure 3-3. AC Voltage Measurements.

1. Set POWER switch to ON.

2. Set FUNCTION switch to k Ω .

3. Set RANGE switch to the desired range. The 2o M Ω range is selected by setting the k Ω and 20 M Ω switches.

4. Connect unknown resistance across V- and COMMON terminals. Select range switch until proper reading is reached.

5. Read resistance on display. Decimal point is correctly positioned.

CAUTION

The resistance measuring circuitry is protected against the application of voltages of up to 250 volts(DC & peak AC). Always turn off power from the circuit being measured when making "in circuit" resistance measurements. Voltage in excess of 250V will damage the instrument.

NOTES

1. When using the 200 ohm range for low resistance measurements, the resistance of the multimeter leads will cause error of about 0.2 ohm. Subtract this error from the reading.

2. Flashing display indicates overload. Switch the appropriate range switch to the next higher range until a steady display appears.

Unit may be used up to 30% overrange on all ranges. For example, 250 k Ω would be displayed as 50.00 on the 200 k Ω range with a flashing display.

Figure 3-4. Resistance Measurements.

1. Set POWER switch to ON.

2. Set FUNCTION switch to DCmA.

3. Set RANGE switch to 2000 or the desired lower range if known. The 10A range switch should be used in conjunction with the 10A input terminal.

4. Connect unknown dc current across mA and COMMON terminals or across 10A and COMMON terminals, as required. Reduce range switch until proper reading is reached.

5. Read dc current on the display. Decimal point is correctly positioned and polarity indicated.

NOTE

A flashing display indicates overload. Switch the appropriate range switch to the next higher range until a steady display appears.

Unit may be used up to 30% overrange on all ranges but not to exceed 2A. For example, 250mA would be displayed as 50.00 on the 200 mA range with a flashing display.

CAUTION

A current in excess of 2A, applied across the mA and COMMON terminals will blow the protecting fuse. The operator should set up all the current measurements with this on mind.

Figure 3-5. DC Current Measurements.

1. Set POWER switch to ON.

2. Set FUNCTION switch to ACmA.

3. Set RANGE switch to 2000 or the desired lower range if known. The 10A range should be used in conjunction with the 10A input terminal.

4. Connect unknown ac current across mA and COMMON terminals or across the 10A and COMMON terminals, as required. Reduce range switch until proper reading is reached.

5. Read ac current on the display. Decimal point is correctly positioned.

NOTE

A flashing display indicates overload. Switch the appropriate range switch to the next higher ranges until a steady display appears.

CAUTION

A current in excess of 2A applied across the mA and COMMON terminals will blow the protection fuse. The operator should set up all the current measurements with this on mind.

Figure 3-6. AC Current Measurement.

1. Set POWER switch to ON.

2. Push DCV and 20 MΩ range.

3. Note display reading, above 5.000 is exceptable. Below 5.000 reading indicates discharged batteries. Recharge batteries as described in paragraph 2-10.

4. Push DCV and DCmA simultaneously and 2000V range.

5. Display reading should be + 888.8.

NOTE

When operation on batteries, do not leave instrument in display test position for a long period. This may result quicker batteries discharge.

Figures 3-7. Battery and Display Check. Model 4020

1. Set POWER switch to ON
2. Remove input leads.
3. Check according to the following table.
4. Follow the sequence in the table.

	Function	Push	Reading	If not, adj.
1	Batteries Condition	20 MΩ+ DCV	+5.000 to +5.700	*
2	Display Test	2+DCV+DCmA	+.8888	**
3	2V Range	2+ACV+ACmA	1.7990 to 1.8010	R-37
4	200mV Range	200+KΩ+DCmA	+199.90 to 180.10	R-39
5	2KΩ Range	2 + KΩ+ ACmA	1.7980 to 1.8020	R-30
6	2mA Range	2 + KΩ+ ACV	.9980 to 1.0020	**

* Charge batteries for 16 hours and recheck.

** Refer to manual for troubleshooting procedure.

NOTE

The above table presents the field calibration limits. For accuracy limits refer to the performance check, section 5-13.

Figure 3-8. Self Check and Self Calibration Model 4021.

SECTION 4

THEORY OF OPERATION

4-1. INTRODUCTION

4-2. This section of the manual contains a description of the circuitry used in the 4020 and 4021. Figures 4-1 and 4-2 are detailed block diagrams for 4020 and 4021 respectively. Basically, the diagram can be broken down into 6 functional areas. These are: DC Voltmeter circuit, Ohm converter, DC current conversion, AC conversion circuit, power supply and a calibrator (4021 only).

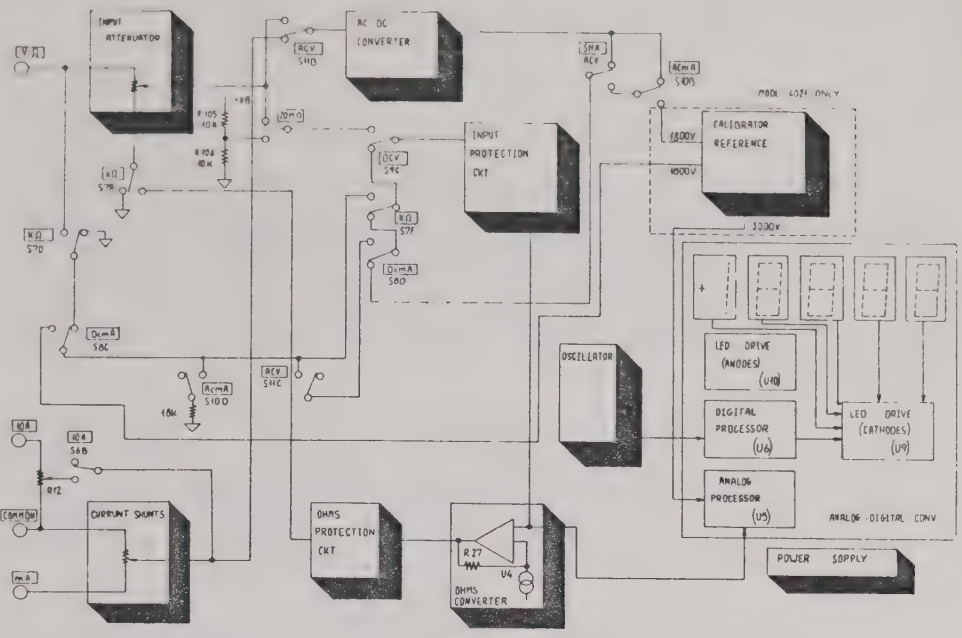
A complete schematic is given in section 7. Refer to this diagram throughout the following circuit description.

4-3. DC VOLTMETER CIRCUIT

4-4. The DC input voltage is coupled to the analog processor U5 via a precision attenuator and a two-section low-pass active filter comprising R19, C8 and R20, C10. The input voltage to the processor is limited by voltage limiters. Diodes CR3, CR5 limit the positive voltage swing, while diodes CR4, CR6 limit the negative voltage swing. Ranging resistors in the attenuator are selected by the front panel RANGE switches to provide a 200 millivolt maximum voltage for the 200 mV range and a 2 volt maximum voltage for all other ranges.

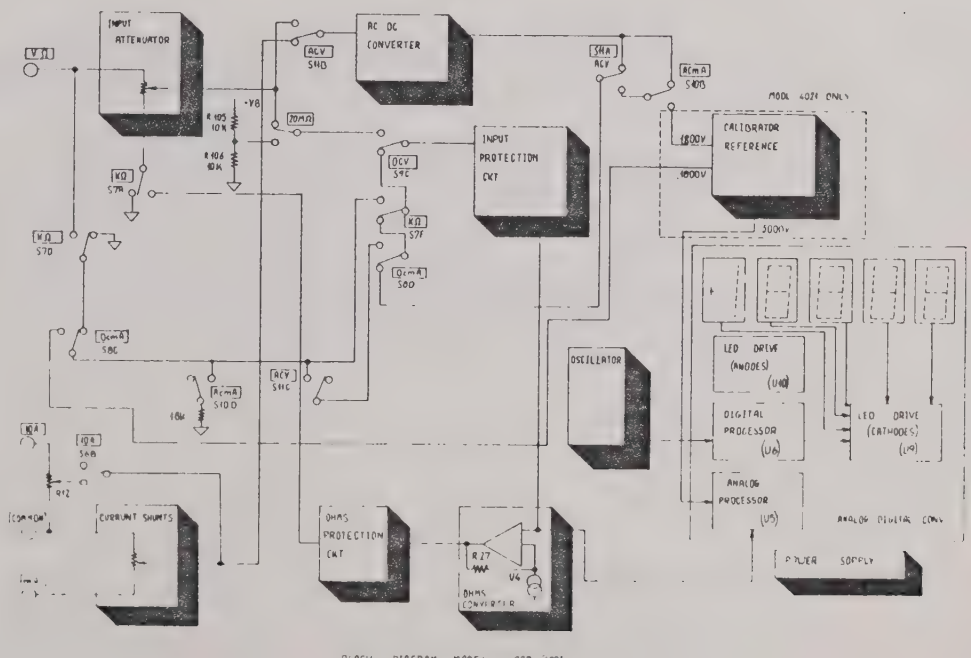
The monolitic analog processor contains a bipolar comparator, a bipolar integrating amplifier, two MOS-FET input unity gain amplifiers, several analog switches and the necessary level shifting drivers to allow the analog and digital processors to be directly interfaced.

The digital processor U6 combines the counting, storage and data multiplexing functions with the random logic necessary to control the function of the analog processor. Output buffers provide the sign, digit strobe and multiplexed BCD data outputs. The digit scan is an interlace format of digits 5,4,3,2 and 1.



BLOCK DIAGRAM, MODEL 4020/4021

Figure 4-1. 4020 Block Diagram.



BLOCK DIAGRAM, MODEL 4020 4021

Figure 4-2. 4021 Block Diagram.

4-5. A measurement cycle consists of two parts: the measure interval and the auto-zero interval. In the measure interval a conversion technique balances the charge supplied by a current proportional to the input voltage with an accumulation of quantized charges equal to a BCD count. The units of quantized charge are provided through pulsewidth-modulation of a reference current.

The auto-zero interval allows the effect of offset, temperatures and drift to be impressed on the auto-zero storage voltage, which is maintained as a reference by the capacitor C12. Therefore, during the succeeding measure interval these effects will be balanced out. The input of the buffer amplifier is grounded during this interval.

4-6. The digital processor has a built-in overrange flashing circuit. The presence of a count of 20,000 or greater in the BCD counter causes the 4 1/2 digit display to blink off during the zero cycle resulting a leak rate equal to the sampling rate.

4-7. The decoder driver U10 translates the BCD information from the digital processor to drive the anodes of the LED readouts DS1, DS2, DS3 and DS4. The cathodes are controlled by the digital processor U9. The digit-strobe pulses from U6 determine which readout receives the proper anode voltage at the proper time. The most significant digit is readout DS5.
Two segments are used to form a numerical "1" and two other segments form the plus or minus polarity signs. The "1" segments are driven by transistor Q8, while the polarity signs are driven by U9.
The decimal point illumination is controlled by U8 and Q7 with the RANGE switches S2B, S3B, S5B and S6A.

4-8. Timing signals for the analog and digital processors are generated by the free-running oscillator Q6, L1, C18, C19, R45 and R46.

4-10. DC and AC CURRENT CIRCUIT

4-11. Direct current is measured by monitoring the voltage drop caused by the unknown current flowing through the precision shunt resistors R7 thru R 12. In each of the ranges shunt resistances are selected to give a full scale voltage of 200 mV to the DC circuit.

4-12. The shunts are protected from damage due to excessive current by a combination of diode-clamps and fuse. Bridge rectifier CR10 is used to clamp and divert excessive positive and negative currents. If current through the shunts exceeds 2 Amps, fuse F2 will open to protect the multimeter. The operator should set up all current measurements with this on mind.

Similarly, AC currents are measured by measuring the voltage drop across the shunt resistors, first passed through the AC to DC converter.

4-13. OHMS CONVERTER CIRCUIT

4-14. Resistance is measured by programming a constant current through the unknown resistance and measuring the resulting voltage drop with the basic DC measurement system. A feedback circuit consist ing of bootstrap amplifier U3 a constant current regulator consisting of Q1 and Q2 and ranging resistors, act as a constant current generator to supply a test current of 1mA for the 200 ohms and 2 Kohms ranges, 100μA for the 20 Kohm range, 10μA for the 2oo Kohm range, 1μA for the 2ooo Kohm range and 100nA for the 2o Mohm range. The bootstrap amplifier otuput is equal to the voltage at the analog processor input U5 (pin 15) plus 1 volt generated by the voltage drop across R27 cuased by the precision 1 mA constant current source. The test current through the unknown resistance is therefore 1V/Range.

4-15. The constant current generator comprises U4, Q3 and Q4. Zener diode CR9 provides a reference voltage of 6.2 volt. This voltage causes a constant voltage drop across R29 and R30 resulting in a constant current of 1 mA to flow in the collector circuit of Q3. U3 is a FET-input high-performance operational amplifier and the current drawn by its input is negligible.

4-16. The overload protection circuit for the ohms converter comprises CR7, CR8, Q3, Q1 and Q2. Positive voltage will reverse bias CR8, Q3 and Q4 which will act like an open switch. Negative voltage will reverse bias CR7 and Q1 which will act like an open switch.

4-17. AC-DC TRUE RMS CONVERTER CIRCUIT

4-18. The AC-DC converter consists of U1 and widband true rms converter U2. Series capacitors C1 and C6 blocks DC voltage so that only AC voltage are measured. U1 is being used as an impedence converter and as a source follower with unity gain for ranges 2,200 and 750V. For 200mV and 20V ranges U1 is used as an amplifier with gain of 10. Gain of 10 is obtained when switches S1B and S3A are closed. In each of the ranges the gain of U1 is selected to give a full scale of 2V to the DC circuit.

4-19. The overload protection circuit for the AC-DC converter comprises R13, CR1 and CR2. Voltage above and below 12V peak will be clamped by CR1 and CR2. The voltage than will drop on R13.

4-2o. POWER SUPPLY

4-21. The power supply circuit provides a regulated plus and minus 12 volt source for the analog and reference circuitry and a regulated +5V source for the timing, digital processor and display circuits.

4-22. The full-wave bridge rectifier CR14 and capacitor C2- supply an unregulated dc voltage. This voltage is applied in parallel to the input of a voltage regulator U11 and a constant current regulator consisting of Q100 and Q101. With the POWER switch in the OFF position, transistor Q100 senses the voltage drop across resistor R100 and corrects, if necessary, the charging current supplied to the batteries.

4-23. The dc to dc converter consists of a solid state switch Q9 and differential amplifier Q10 and Q11. The pulses generated are rectified by diodes CR11 and CR12. Capacitors C24 and C25 filter the rectified voltage.

4-24. CALIBRATOR (Model 4021 only)

4-25. Model 4021 features a built-in calibrator for a quick self check and field recalibration. U200 is an ultra stable voltage reference which supplies 5V. Super stable resistors R200 through R204 divide this voltage to give 1.8V and .18V for the internal calibration. Switches S11A and S10B are combined to route 1.8V directly to the analog processor while S8C and S7F are combined to route the .18V.

R206 is routed via S10D and S7F to the KΩ input circuit to provide a stable 1.8 KΩ resistor for KΩ calibration. R7 through R11 are routed via S11C and S7F to the KΩ circuit for mA calibration.

SECTION 5

MAINTENANCE AND CALIBRATION

5-1. INTRODUCTION

5-2. This section provides maintenance, service information, performance test, calibration and troubleshooting for the 4020 and 4021.

5-3. TEST EQUIPMENT

5-4. Table 5-1. REQUIRED TEST EQUIPMENT

INSTRUMENT TYPE	PURPOSE	SPECIFICATIONS
DC Voltage Standard	DC Voltage Calibration	1mV to 1200V ±0.005%
Precision Resistor	Alignment and Calibration	190Ω, 1.9KΩ, 19kΩ 190kΩ 1.9MΩ and 19MΩ ± 0.01%
AC Voltage Source	AC Voltage Calibration	1 mV to 1200V, ± 0.01%
DC Current Source	DC Current Calibration	1 µA to 2A, ± 0.01%
AC Current Source	AC Current Calibration	1 µA to 2A, ± 0.05%
Frequency Counter	For Timing Measurement	DC to 1 MHz

5-5. INSTRUMENT COVER REMOVAL

5-6. To remove the top or bottom cover, remove the two screws on the sides of the rear plastic bezel. Carefully remove the rear bezel and then slide out the top and bottom covers. To replace covers, reverse procedure.

WARNING

115/230 VAC line voltage are exposed when top cover is removed. Disconnect the power cord from the power source before removing the covers.

5-7. CLEANING

5-8. The 4020/4021 should be cleaned as often as operating conditions require. Thoroughly clean both the inside and outside of the instrument. Remove dust from inaccessible areas with low pressure compressed air or vacuum cleaner. Use alcohol applied with a cleaning brush to remove accumulations of dirt or grease from connector contacts and component terminals. Clean the exterior of the instrument and the front panel with a mild detergent mixed with water, applying the solution with a soft, lint-free cloth.

5-9. FUSE REPLACEMENT

5-10. The line power fuse is located on the rear panel. To replace the fuse, turn the fuseholder cover anticlockwise. The current range protection fuse is also located on the rear panel. When replacement is required, install a 2A 5x20 mm medium acting fuse LITTLEFUSE type 211001 or equivalent.

5-11. REPAIR AND REPLACEMENT

5-12. Repair and replacement of electrical and mechanical parts must be accomplished with care and caution. Printed circuit component boards can become warped, cracked or burned from excessive heat or mechanical stress. The following repair techniques are suggested to avoid inadvertant destruction or degradation of parts and assemblies.

Use ordinary 60/40 solder and a 35 to 40 watt pencil type soldering iron on the circuit board. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the circuit from the base material. Keep the soldering iron in contact with the PC board for a minimum time to avoid damage to the components or printed conductors.

To desolder components use a commercial "solder sipper", or better, solderremoving SOLDER-WICK, size 3, manufactured by SOLDER REMOVAL CO., Covina, California.

Always replace a component with its exact duplicate as specified in the parts list.

5-13. PERFORMANCE CHECK

5-14. The following performance check verifies proper operation of the instrument, and should normally be used:

a) as part of incoming inspection of instrument specifications;

b) as part of troubleshooting procedure;

c) after any repairs or adjustments, before returning instrument to regular service.

5-15. DC VOLTAGE ACCURACY CHECK

To check the accuracy of the 4020 and 4021 for DC voltage measurements, proceed as follows:

a) Set POWER switch to ON.

b) Set FUNCTION switch to DCV.

c) Set output of voltage standard to zero.

d) Connect the V- and COMMON INPUT terminals on the DMM to the (+) and (-) output terminals respectively on the voltage standard.

e) Check accuracy at each setting of voltage standard listed in Table 5-2. In each case the readout should be within the tolerance shown.

f) Reduce the voltage standard output to zero and disconnect the test instrument from the DMM.

Table 5-2. DC Voltage Accuracy Check

Standard Voltage	Range Switch Setting	Readout Limits 4020		Readout Limits 4021	
		min.	max.	min.	max.
0.0000	200 mV	± 00.00	± 00.02	± 00.00	± 00.02
±0.0100		± 00.99	± 01.01	± 00.98	± 01.02
±0.1000		± 99.97	± 100.03	± 99.94	± 100.06
±0.1900		± 189.95	± 190.05	± 189.89	± 190.11
0.0000	2 V	± .0000	± .0002	± .0000	± .0002
±1.0000		± .9997	± 1.0003	± .9994	± 1.0006
±1.9000		± 1.8995	± 1.9005	± 1.8989	± 1.9011
+ 10.000	20 V	± 9.997	± 10.003	± 9.994	± 10.006
+ 19.000		±18.995	± 19.005	±18.989	± 19.011
+ 100.00	200 V	± 99.97	± 100.03	± 99.94	± 100.06
+ 190.00		± 189.95	± 190.05	± 189.89	± 190.11
+ 7500.0	1200V	± 499.8	± 500.2	± 499.7	± 500.3
+ 1000.0		± 999.7	± 1000.3	± 999.4	± 1000.6

5-16. DC CURRENT ACCURACY CHECK

a) Set POWER switch to ON.

b) Set FUNCTION switch to DCmA.

c) Set output of current standard to zero.

d) Connect the mA and COMMON INPUT terminals on the 4020/4021 to the current standard.

e) Check accuracy at each setting of the DC current standard listed in Table 5-3. In each case the readout should be within the tolerance shown.

f) Disconnect the current source from the DMM.

Table 5-3. DC CURRENT ACCURACY CHECK

Standard Current (milliamps)	Range Switch Setting	Readout Limits 4020		Readout Limits 4021	
		min.	max.	min.	max.
0.0000	200 µA	± 00.02	± 00.02	± 00.00	± 00.02
± 0.0100		± 00.98	± 01.02	± 00.97	± 01.03
± 0.1000		± 99.88	± 100.12	± 99.60	± 100.40
± 0.1900		± 189.78	± 190.22	± 189.30	± 190.70
± 1.0000	2 mA	± .9988	± 1.0012	± .0060	± 1.0040
± 1.9000		± 1.8978	± 1.9021	± 1.8930	± 1.9070
± 19.000	20 mA	± 18.978	± 19.021	± 18.930	± 19.070
± 190.00	200 mA	± 189.78	± 190.21	± 189.30	± 190.7o
± 1900.0	2000 mA	± 1897.8	± 1902.1	± 1893.0	± 1907.0
± 9000.0	10 A	± 8.988	± 9.012	± 8.960	± 9.040

5-17. RESISTANCE ACCURACY CHECK

a) Set POWER switch to ON.

b) Set FUNCTION switch to KΩ.

c) Connect the V- and COMMON INPUT terminals of the 4020/4021 to the standard resistor (see Table 5-4).

d) Check accuracy of the resistance standard listed in Table 5-4. In each case the readout should be within the tolerance shown.

NOTE

Lead resistance must be subtracted on 200Ω and 2 KΩ ranges, otherwise an error equal to the lead resistance will be oberserved.

Table 5-4. Resistance Accuracy Check

Standard Resistance	Range Switch Setting	Readout Limits 4020		Readout Limits 4021	
		min.	max.	min.	max.
00.00	200 Ω	00.00	00.2	00.00	00.02
190	200 Ω	189.94	190.06	189.78	190.22
1.9 K	2 K	1.8994	1.9006	1.8978	1.9022
19 K	20 K	18.994	19.006	18.978	19.022
190 K	200 K	189.94	190.06	189.78	190.22
1.9 M	2000 K	1899.4	1900.6	1397.8	1902.2
19 M	20 M	18.989	19.011	18.978	19.022

5-18. AC VOLTAGE ACCURACY CHECK

a) Set POWER switch to ON.

b) Set FUNCTION switch to ACV.

c) Set output of voltage standard to zero.

d) Connect the V - and COMMON terminals on the 4020/4021 to the output terminals of the voltage source.

e) Check the accuracy at each setting of voltage standard listed in Table 5-5 for 4020 and Table 5-6 for 4021. In each case the readout should be within the tolerance shown.

f) Reduce the voltage standard to zero and disconnect the voltage source from the DMM.

Table 5-5. AC VOLTAGE ACCURACY CHECK 4020

AC Voltage	Range Switch Setting	Readout Limits 50Hz to 100Hz		Readouts Limits 100Hz to 10kHz		Readouts Limits 10kHz to 20kHz	
		min.	max.	min.	max.	min.	max.
00.00 mV	200 mV	00.00	00.03	00.00	00.03	00.00	00.03
100.00 mV		99.40	100.60	99.75	100.25	99.40	100.60
190.00 mV		188.80	191.20	189.40	190.60	188.80	191.20
.2000 V	2 V	.1970	.2030	.1986	.2014	.1970	.2030
1.0000 V		.9940	1.0060	.9975	1.0025	.9940	1.0060
1.9000 V		1.8880	1.9120	1.8940	1.9060	1.8880	1.9120
2.000 V	20 V	1.970	2.030	1.986	2.014	1.970	2.030
10.000 V		9.940	10.060	9.975	10.025	9.940	10.060
19.000 V		18.880	19.120	18.940	19.060	18.880	19.120
20.00 V	200 V	19.70	20.30	19.86	20.14	19.70	20.30
100.00 V		99.40	100.60	99.75	100.25	99.40	100.60
190.00 V		188.80	191.20	189.40	190.60	188.80	191.20
200 V		197.0	203.0	198.6	201.4*		
500 V		495.5	504.5	497.0	503.0*		

* 100 Hz to 1 KHz.

Table 5-6. AC VOLTAGE ACCURACY CHECK 4021

AC Voltage Standard	Range Switch Setting	Readout Limits 45 Hz to 1oo Hz		Readout Limits 1ooHz to 1oKHz		Readout Limits 1o KHZ to 2o KHz	
		min.	max.	min.	max.	min.	max.
00.00 mV	200 mV	00.00	00.05	00.00	00.05	00.00	00.05
100.00 mV		98.80	101.20	99.20	100.80	93.80	101.20
190.00 mV		187.80	192.20	188.60	191.40	187.80	192.20
.2000 V	2 V	.1960	.2040	.1968	.2032	.1960	.2040
1.0000 V		.9880	1.0120	.9920	1.0080	.9880	1.0120
1.9000 V		1.8780	1.9220	1.8860	1.9140	1.8780	1.9220
2.000 V	20 V	1.960	2.040	1.968	2.032	1.960	2.040
10.000 V		9.880	10.120	9.920	10.080	9.880	10.120
19.000 V		18.780	19.220	18.860	19.140	18.780	19.220
20.00 V	200 V	19.60	20.40	19.68	20.32	19.60	20.40
100.00 V		88.80	101.20	99.20	100.80	98.80	101.20
190.00 V		187.80	192.20	188.60	191.40	187.80	192.20
200 V	2000 V	196.0	204.0	196.8	203.2*		
750 V		740.5	759.5	743.5	756.5*		

*100 Hz to 5 kHz

5-19. AC CURRENT ACCURACY CHECK

a) Set POWER switch to ON.

b) Set FUNCTION switch to ACmA.

c) Set output of current standard to zero.

d) Connect the mA and COMMON terminals on the 4020/4021 to the output terminals of the current source.

e) Check the accuracy at each setting of current standard listed in Table 5-7. In each case the readout should be within the tolerance shown.

Table 5-7. AC Current Accuracy Check

AC Current Standard	Range Switch Setting	4020 Readout Limits 30Hz to 100Hz min.	4020 Readout Limits 30Hz to 100Hz max.	4020 Readout Limits 100Hz to 5KHz min.	4020 Readout Limits 100Hz to 5KHz max.	4021 Readout Limits 45Hz to 5 KHz min.	4021 Readout Limits 45Hz to 5 KHz max.
00.00 uA	200 uA	00.00	00.05	00.00	00.05	00.00	00.07
100.00 uA		99.00	101.00	99.60	100.40	98.90	101.10
190.00 uA		188.00	192.00	189.20	190.80	187.90	192.10
1.0000 mA	2 mA	.9900	1.0100	.9960	1.0040	.9890	1.0110
1.9000 mA		1.8800	1.9200	1.8920	1.9080	1.8790	1.9210
10.000 mA	20 mA	9.900	10.100	9.960	10.040	9.990	10.110
19.000 mA		18.800	19.200	18.920	19.080	18.790	19.210
100.00 mA	200 mA	99.00	101.00	99.60	100.40	99.90	101.10
190.00 mA		188.00	192.00	189.20	190.80	187.90	192.10
1000.0 mA	2000 mA	990.0	1010.0	996.0	1004.0	999.0	1011.0
1900.0 mA		1880.0	1920.0	1982.0	1908.0	1879.0	1921.0
9.000 A	10 A	8.900	9.100	8.970	9.030	8.890	9.110

5-20. ALIGNMENT AND CALIBRATION PROCEDURES

5-21. If any of the performance checks fail, a recalibration may be required. Table 5-1 lists the test equipment that is required to perform complete calibration of the instrument.

5-22. POWER SUPPLIES

5-23. The Model 4020/4021 has no power supply adjustments, but voltage limits should be checked before recalibration. Test points are clearly marked on the upper side of the P.C. board.

Table 5-8. DC Power Supply Checkout

Supply	Voltage Limits	Maximum Ripple
+12V	+11 to +13V	4 mV P-P
-12V	-11 to -13V	6 mV P-P

5-24. CALIBRATION PROCEDURE 4020

5-25. All calibration procedures are performed with the POWER switch turned on. The top cover should be removed to allow access to test points and adjustments. Refer to component layout when necessary, for determining adjustment points. Before any attempt to calibrate the instrument, make sure all circuits are working properly according to the troubleshooting procedure.

5-26. Push DCV and DCmA simultaneously to get + 8888 reading on the display and allow about twenty minutes to warm-up.

5-27. Push DCV and 2000V range. With no leads connected to input terminals, select C-13 to get a stable reading of +0000.0.

5-28. Push DCmA and 2000 mA range. With no leads connected to input terminals, adjust R18 - ZERO OFST - to get a reading of -0000.1 to + 0000.1.

5-29. Push DCV and 2V range. Apply 1.9V to input terminals and adjust R37 - 2V ADJ - to give a reading of + 1.9000± 1.9000 ±1LSD on the display.

5-30. Reverse leads. Display reading should be - 1.9000 + 1 LSD. If reading is correct, repeat steps 5-26 through 5-30.

5-31. Push DCV and 200 mV range. Apply 190 mV to input terminals and adjust R39 - 200 mV ADJ - to give a reading of +190.00 ±1 LSD on the display.

5-32. Reverse leads. Display reading should be -190.00 ± 2 LSD. If reading is incorrect, repeat steps 5-28, 5-31 and 5-32.

5-33. Remove input leads. Push DC and 2000V range. Apply 10V between TP-3 and COMMON and adjust R2 to give a reading of 1000.0 ± 1 LSD on the display.

5-34. Push DCV and 200V range. Apply 10V between TP4 and COMMON and adjust R1 to give a reading of 100.00 ±1LSD on the display.

5-35. Push DCV and 2000V range. Apply 1000V to input terminals and adjust R2 to give a reading of the display.

5-36. Disconnect DC calibrator. Set R30 - KΩ ADJ - to midrange. Push KΩ and 200K range. Apply 190 KΩ and select R29 to give a reading within 50 counts from the exact reading. Adjust R30 - KΩ ADJ - to give a reading of 190.00± 2 LSD on the display. Check all KΩ ranges. If not within specifications, repeat steps 5-33 through 5-36.

5-37. Disconnect ohms calibrator. Push ACmA and 2000 mA range. Adjust R-18 AC ZERO ADJ to give a reading of 0000.0 ± 1 LSD on the display.

5-38. Push ACV and 2V range. Apply 1.9V rms 400 Hz to input terminals. Check if within specifications.

Note: There is no adjustment to 2V AC range. If reading is not within specifications, repeat step 5-29.

5-39. Push ACV and 200 mV range. Apply 190 mV rms 400 Hz to input terminals. If reading is not within specifications, replace the matched set R14 and R15.

5-4o. Push ACV and 200V range. Apply 190V rms 4oo Hz to input terminals. Adjust R60 to give a reading of 190.00 ± 10 digits.

5-41. Push ACV and 200V range. Apply 190V rms 10 KHz to input terminals and adjust C2 - 200V HI FREQ ADJ - to give a reading of 190.00 ± 5 LSD.

NOTE: Covering the instrument with the top cover will change the calibration slightly. Add this change to the reading when adjusting without the top cover.

5-42. Disconnect AC calibrator. Push DCmA and 2000mA range. Apply 1.9A to input terminals and adjust R11 - mA ADJ - to give a reading of 1.9000 ± 5 LSD on the display.

5-43. Push ACmA and 2000 mA range. Apply 1.9A r ms 4oo Hz to input terminals. Check reading, if not within specifications, repeat step 5-41.

5-44. Push DCmA and 10A range. Apply 9A to input terminals and adjust R12 to give a reading of 9.000 ± 5 LSD on the display.

5-45. CALIBRATION PROCEDURE 4021

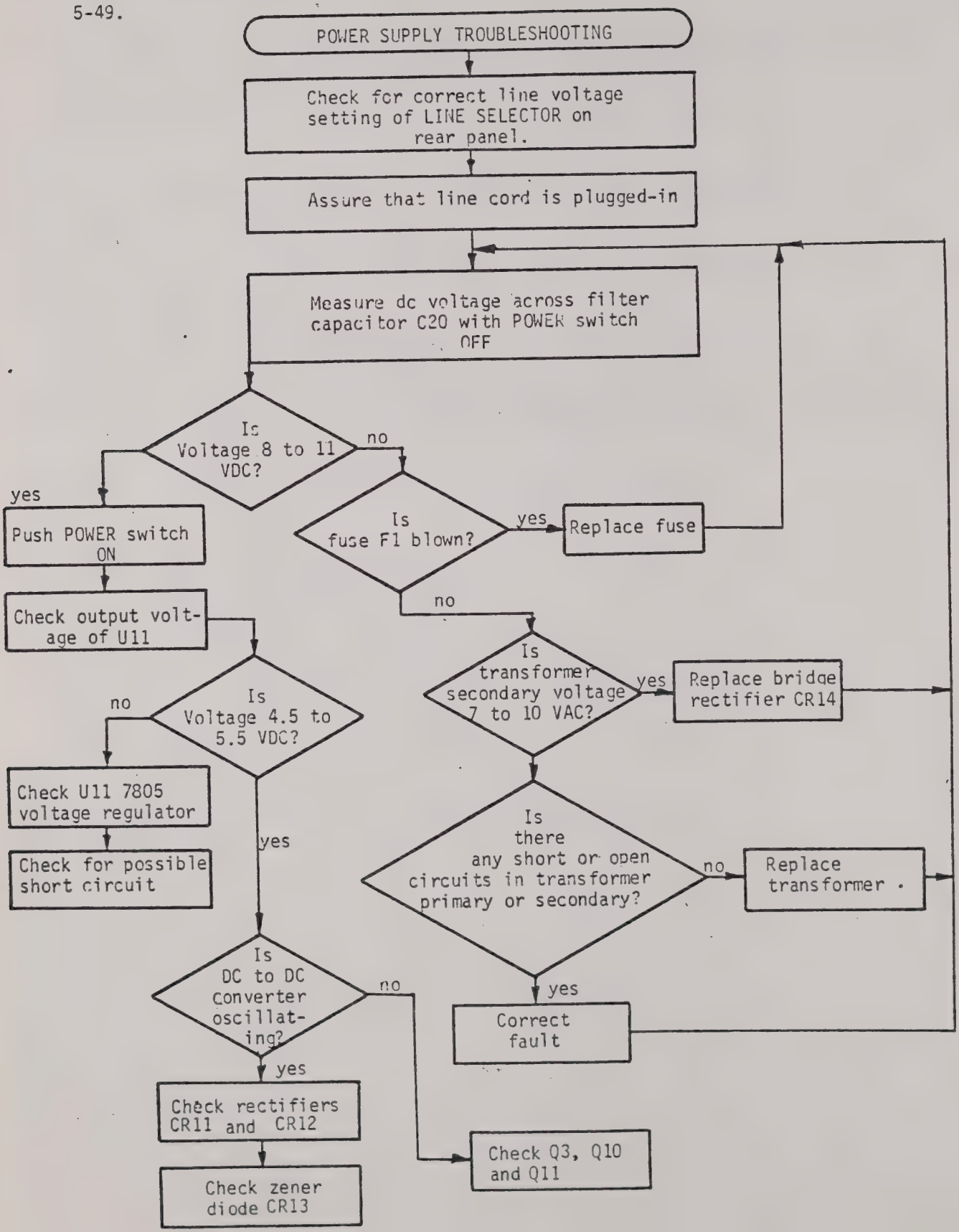
5-46. Follow steps 5-25 through 5-32 in the 4020 calibration procedure.

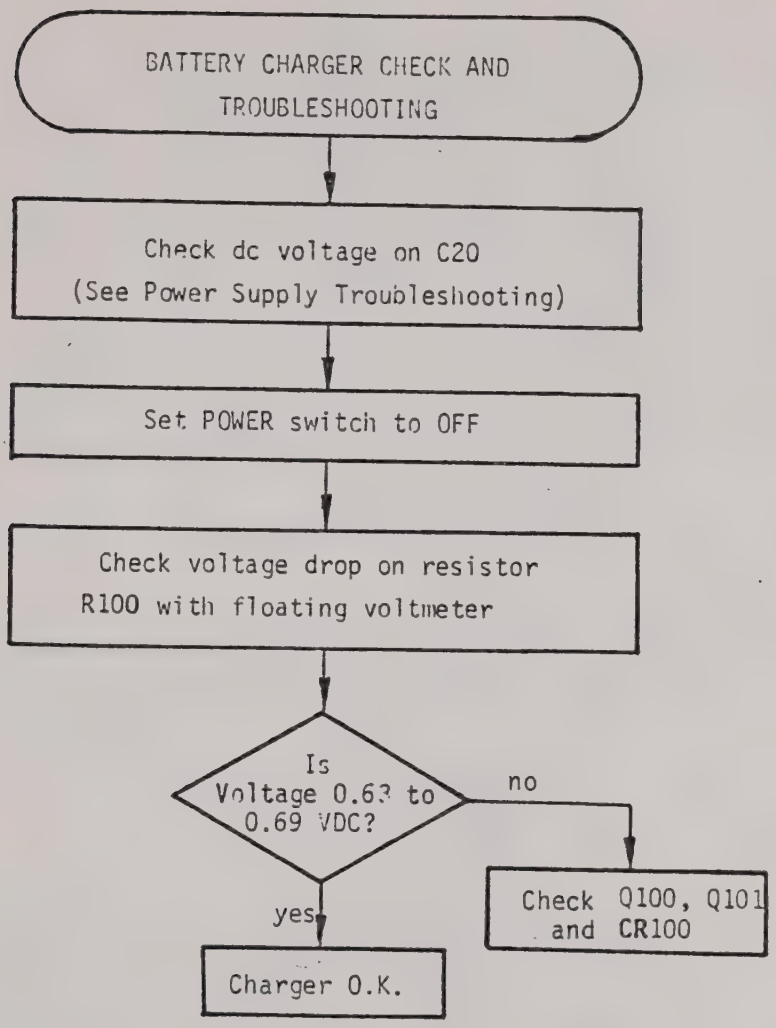
5-47. Follow steps 5-36 through 5-39 and 5-41 through 5-44.

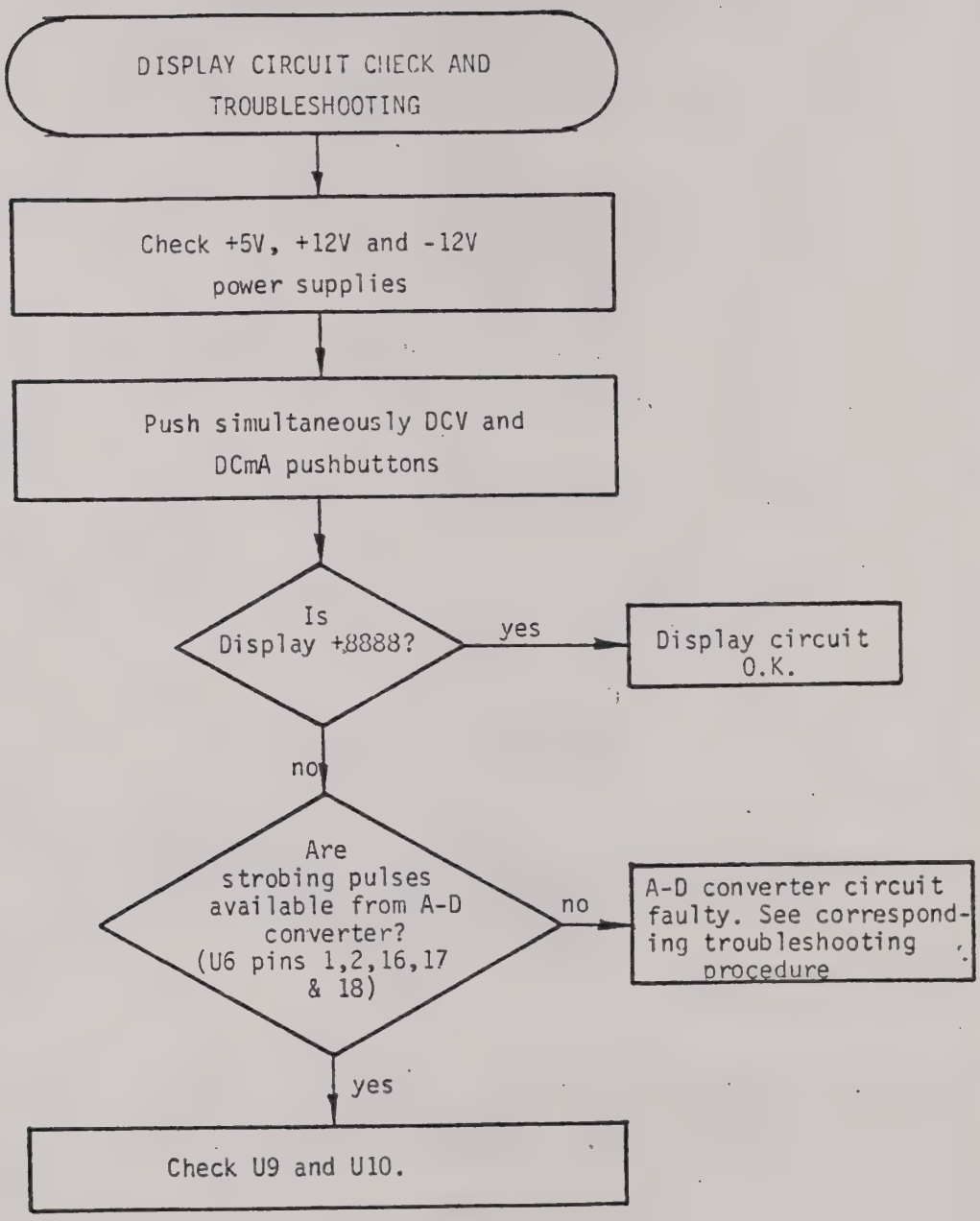
5-48. Complete calibration can performed using the internal calibrator. Follow the sequence described in Figure 3-8 or the table printed on the bottom cover of your 4021. Field calibration requires no additional equipment.

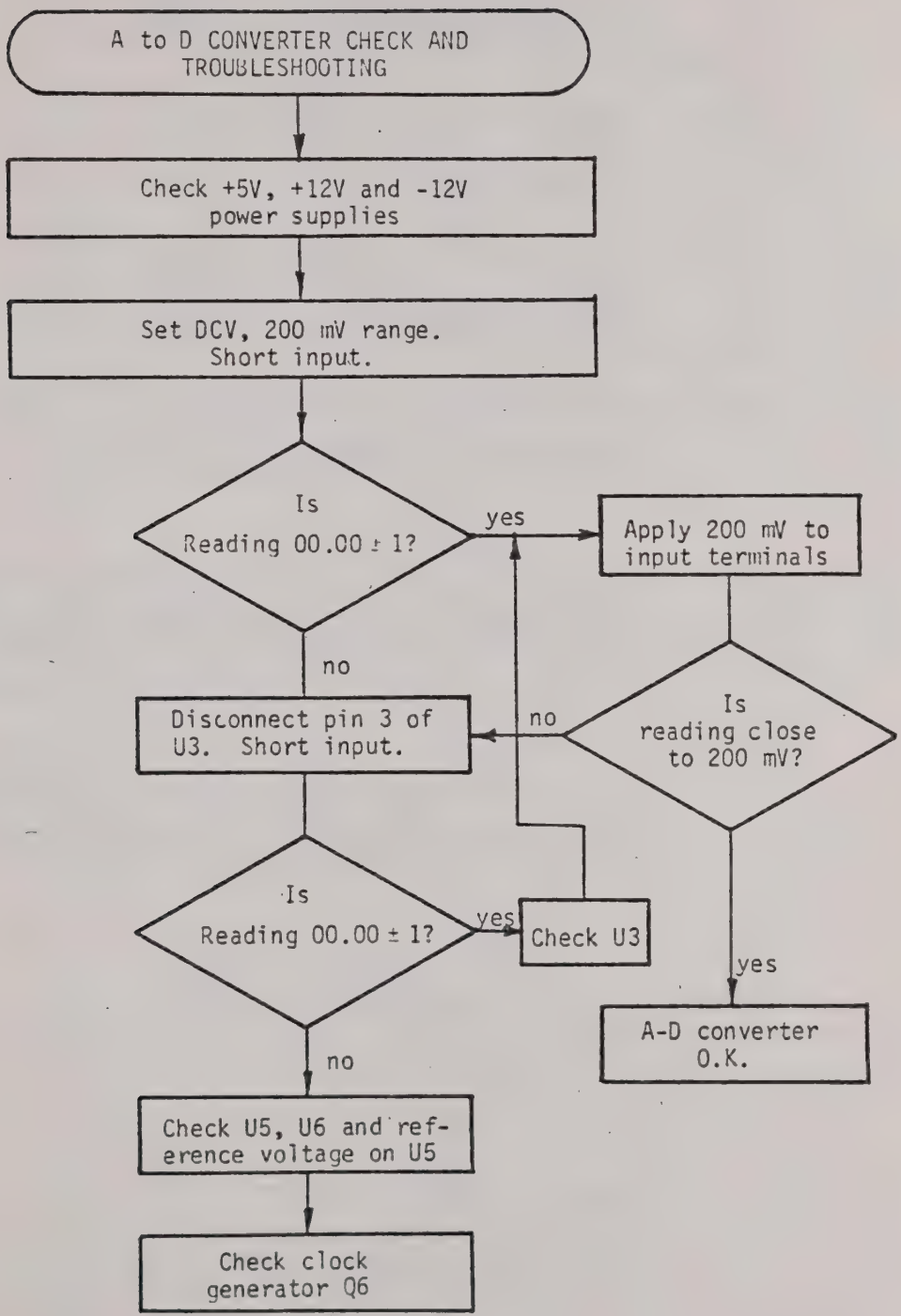
5-48. TROUBLESHOOTING PROCEDURE

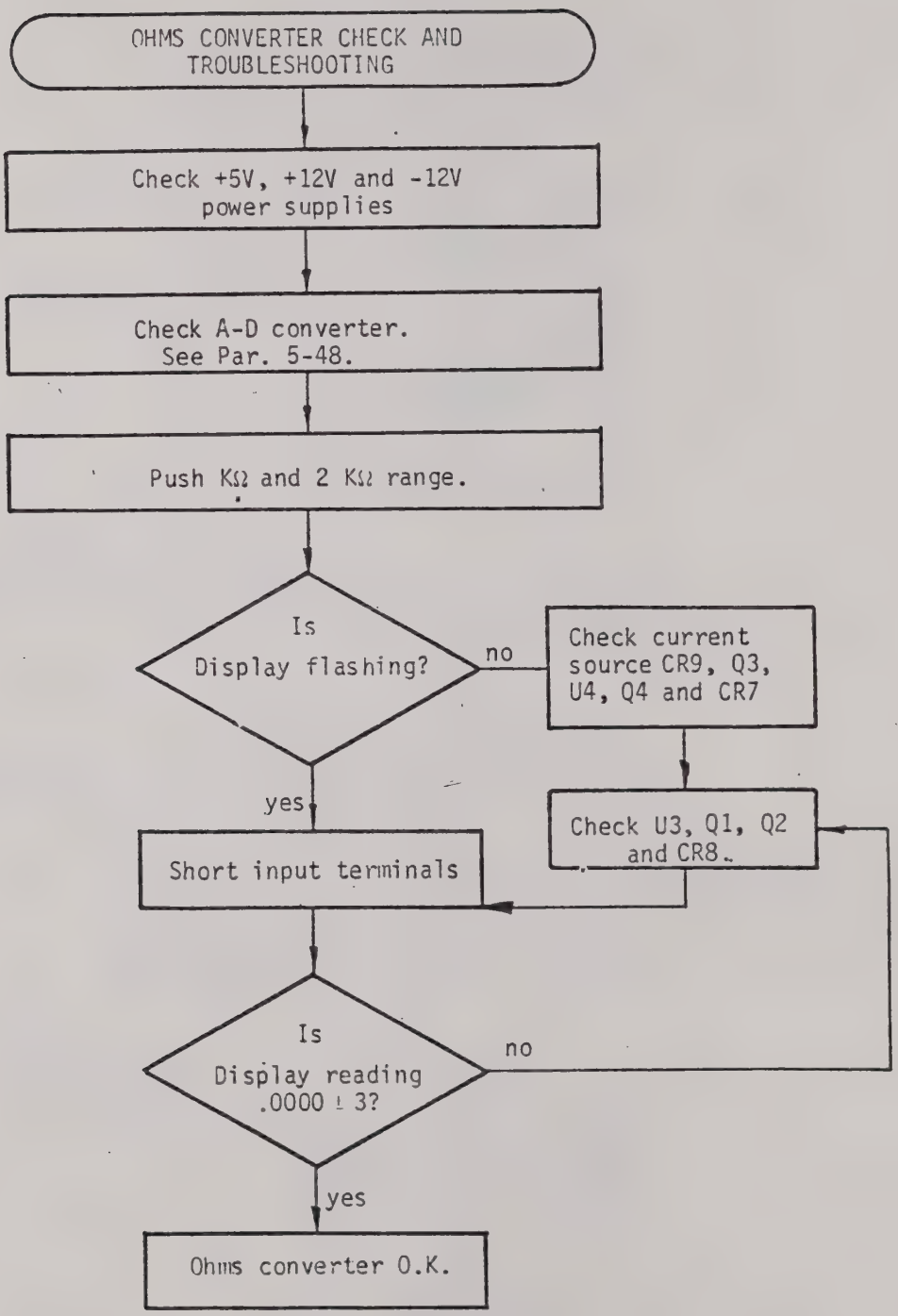
5-49.

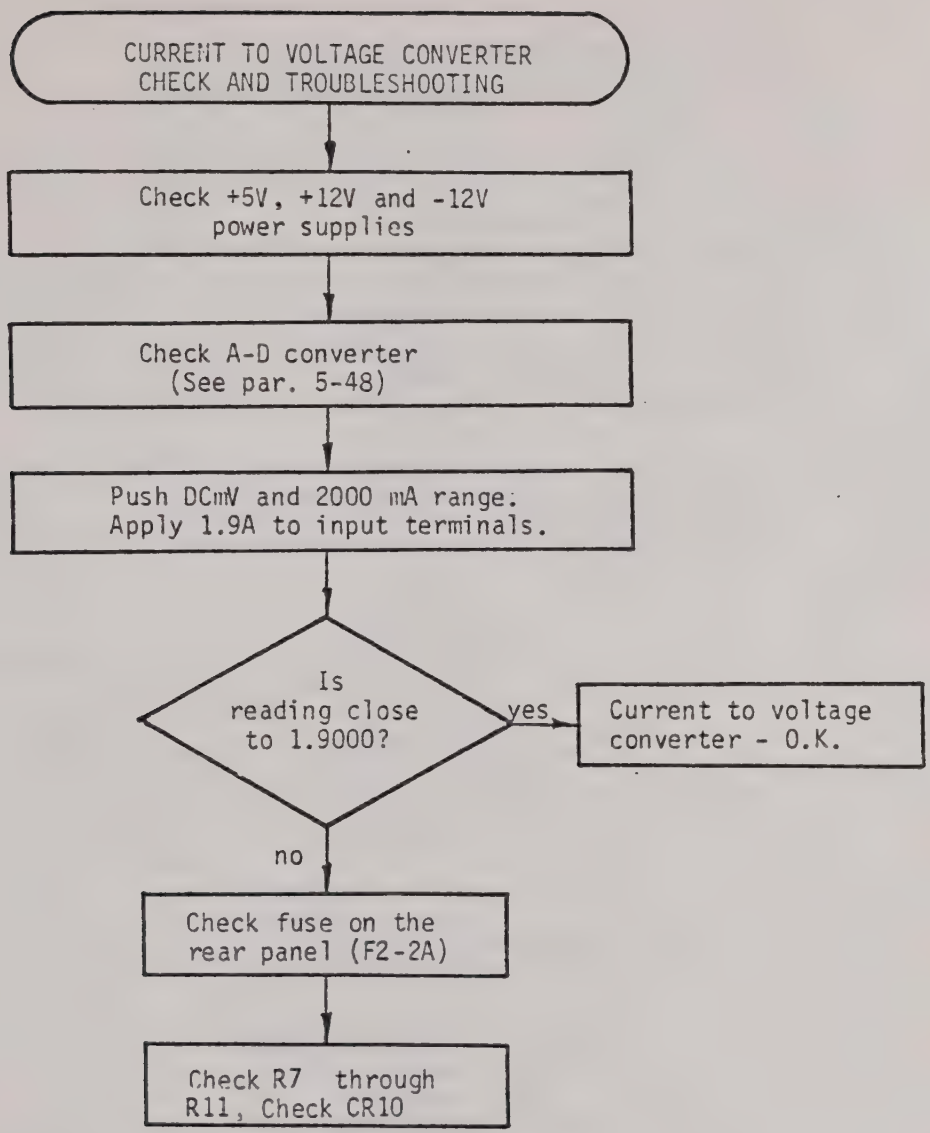

POWER SUPPLY TROUBLESHOOTING
Check for correct line voltage setting of LINE SELECTOR on rear panel.
Assure that line cord is plugged-in
Measure dc voltage across filter capacitor C20 with POWER switch OFF
Is Voltage 8 to 11 VDC?
no
yes
Push POWER switch ON
Check output voltage of U11
Is fuse F1 blown?
yes
Replace fuse
no
Is transformer secondary voltage 7 to 10 VAC?
yes
Replace bridge rectifier CR14
Is Voltage 4.5 to 5.5 VDC?
no
Check U11 7805 voltage regulator
Check for possible short circuit
yes
Is there any short or open circuits in transformer primary or secondary?
no
Replace transformer .
yes
Correct fault
Is DC to DC converter oscillating?
no
yes
Check rectifiers CR11 and CR12
Check zener diode CR13
Check Q3, Q10 and Q11


BATTERY CHARGER CHECK AND TROUBLESHOOTING
Check dc voltage on C20 (See Power Supply Troubleshooting)
Set POWER switch to OFF
Check voltage drop on resistor R100 with floating voltmeter
Is Voltage 0.63 to 0.69 VDC?
no
yes
Check Q100, Q101 and CR100
Charger O.K.

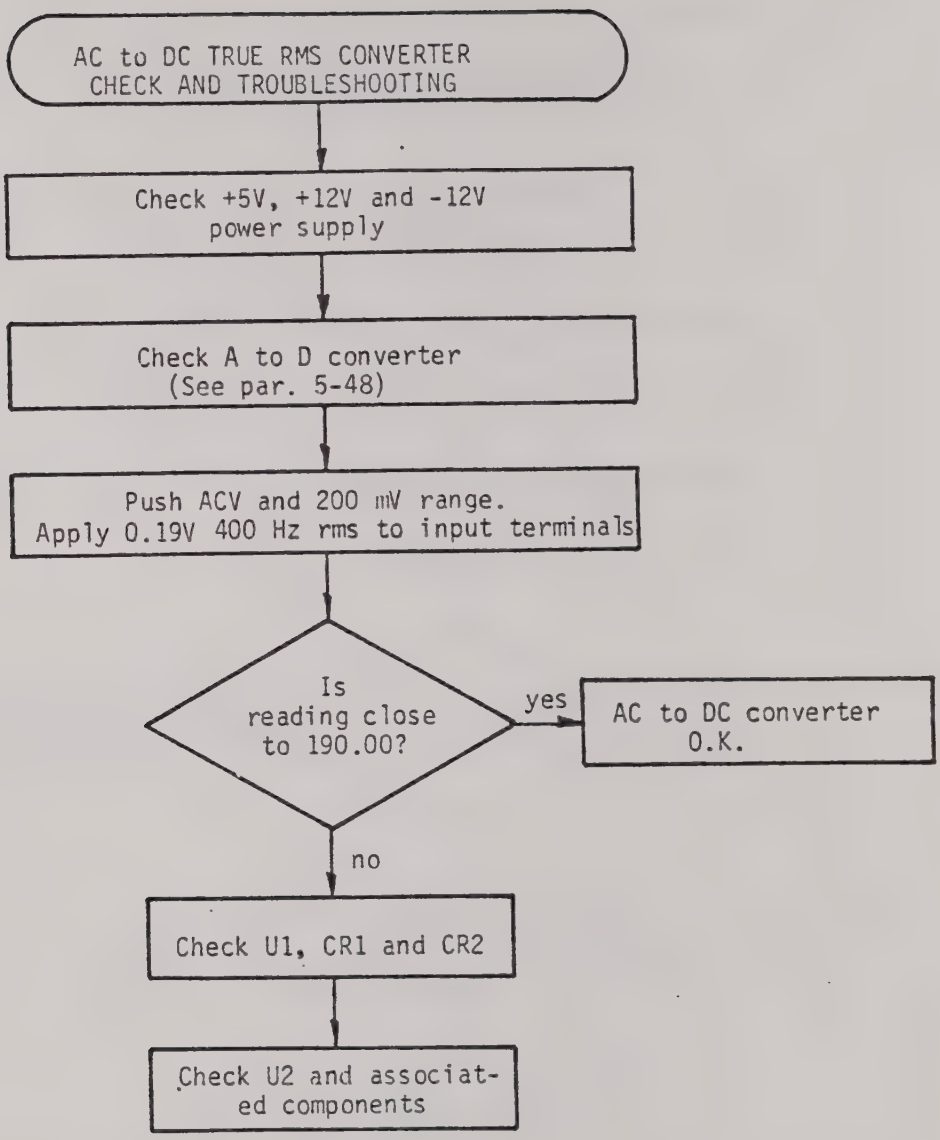

DISPLAY CIRCUIT CHECK AND TROUBLESHOOTING
Check +5V, +12V and -12V power supplies
Push simultaneously DCV and DCmA pushbuttons
Is Display +8888?
yes
Display circuit O.K.
no
Are strobing pulses available from A-D converter? (U6 pins 1,2,16,17 & 18)
no
A-D converter circuit faulty. See corresponding troubleshooting procedure
yes
Check U9 and U10.


A to D CONVERTER CHECK AND TROUBLESHOOTING
Check +5V, +12V and -12V power supplies
Set DCV, 200 mV range. Short input.
Is Reading 00.00 ± 1?
yes
Apply 200 mV to input terminals
no
Disconnect pin 3 of U3. Short input.
no
Is reading close to 200 mV?
Is Reading 00.00 ± 1?
yes
Check U3
yes
A-D converter O.K.
no
Check U5, U6 and reference voltage on U5
Check clock generator Q6


OHMS CONVERTER CHECK AND TROUBLESHOOTING
Check +5V, +12V and -12V power supplies
Check A-D converter. See Par. 5-48.
Push KΩ and 2 KΩ range.
Is Display flashing?
no
Check current source CR9, Q3, U4, Q4 and CR7
yes
Check U3, Q1, Q2 and CR8.
Short input terminals
Is Display reading .0000 ± 3?
no
yes
Ohms converter O.K.


CURRENT TO VOLTAGE CONVERTER CHECK AND TROUBLESHOOTING
Check +5V, +12V and -12V power supplies
Check A-D converter (See par. 5-48)
Push DCmV and 2000 mA range. Apply 1.9A to input terminals.
Is reading close to 1.9000?
yes
Current to voltage converter - O.K.
no
Check fuse on the rear panel (F2-2A)
Check R7 through R11, Check CR10

5-55:



5-56. INTERMITTENT SWITCHES

5-57. When the multimeter has been stored for a period of time or has been exposed to caustic fumes, acid fumes, oil fumes, hydrogen sulfide, or other contaminants, the pushbutton switches may become noise or intermittent even though specially treated high quality contacts are used throughout.

Push each button ten or more times to permit self-wiping action of switches to clean the contacts and eliminate the problem.

SECTION 6

PARTS LIST

The replacement parts listed are available from the vendors listed or from KONTRON Electronic .

When ordering replacement parts always give the following information:

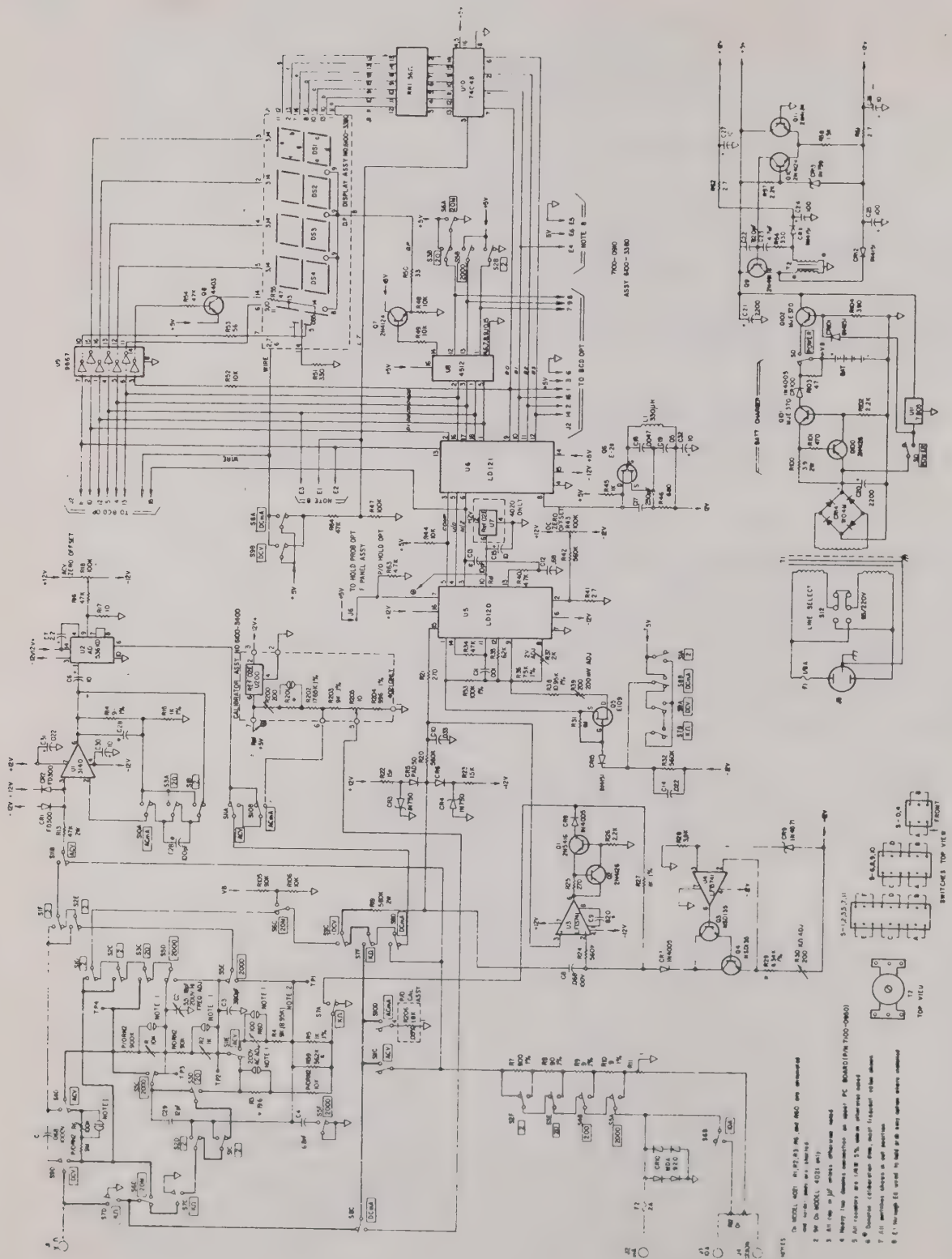
a) Instrument Model number
b) Serial number
c) Kontron Part number
d) Schematic symbol number
e) Identification of the part.

KONTRON will do its best to improve the instrument and make changes in style of components and replacemet parts. Replacement parts may differ in appearance from those found in your instrument but are always equal or superior in performance.

Parts list is similar for 4020 and 4021, Parts marked with 4020 will appear only on the Model 4020. Parts marked with 4021 will appear only on the Model 4021. Parts not marked will appear on both DMMs.

01121	Allen-Bradley Co., Milwaukee, Wisconsin.
04713	Motorola Semiconductors, Phoenix, Arizona.
01295	Texas Instruments, Dallas, Texas.
12617	Hamlin Inc., Lake Mills, Wisconsin.
17856	Siliconix Inc., Sunnyvale, California.
18323	Signetics Corp., Sunnyvale, California.
22767	ITT Semiconductors, Lawrence, Massachusetts.
27014	National Semiconductor Corp., Santa Clara, Calif.
56289	Sprague Electric Co., North Adams, Massachusetts.
71236	Elmenco, Willimantic, Conneticut.
73899	JFD Electronics Co., Brooklyn, New York.
75915	Littlefuse Inc., Des Plaines, Illinois.
80031	Mepco, Morristown, New Jersey.
80294	Bourns, Riverside, California.
91637	Dale Electronics, Columbus, Nebraska.
95275	Vitramon Inc., Bridgeport, Conneticut.
28480	Hewlett Packard, Palo-Alto, California.

SECTION 7 CIRCUIT DIAGRAM



SECTION 8

OPTIONS AND ACCESSORIES

8-1. INTRODUCTION

8-2. This section contains information for the options and accessories which can be used with Models 4020 and 4021 Digital Multimeters. Each option and accessory is described individually. Field installation procedures, operating and maintenance instructions, a replaceable parts list and a schematic diagram are included.

8-3. INTERNAL RECHARGEABLE BATTERY PACK, OPTION -B .

8-4. General. Models 4020 and 4021 can be operated either from a power line or internal batteries. Every DMM has the internal charger as a built-in feature including the batteries holder. Batteries must be bought separately. All you have to do is to install the batteries, charge them and the DMM is ready to operate. The batteries are charged by setting the POWER switch to the OFF position and connecting the ac power to the instrument. When the DMM is in the ON position, the batteries are trickle charged.

8-5. Specifications

Continuous Operation	:	5 hours typical
Charge Time	:	16 hours
Battery Life	:	More than 400 charge discharge cycles.
Battery Type	:	Four NiCad "c" cells.

Warning

Use only nickel cadmium cells to power the Models 4020 and 4021. Use of alkaline or carbon zinc cells may cause damage and void the warranty.

8-6. Operation. When the batteries are fully charged, the Models 4020 and 4021 may be disconnected from the ac power line and operate for more than 5 hours. The battery-charge condition may be checked by disconnecting the ac power and pushing in the power (S0), DCV (S9) and 20 MΩ (S6). A display reading of greater than 5.000 indicates that the batteries are charged. Fully charged batteries will indicate above 5.700.

N O T E

It is recommended that Ni Cad batteries be recharged at least every 90 days and that they be stored where the temperature is below + 30°C (86°F).

8-7. Theory of Operation. (Refer to the main schematic dwg. for details.)
With POWER switch in the OFF position and ac power connected to the DMM CR14 supplies apprx. 9V to the constant current regulator comprises of Q100, Q101 and associated components. With the DMM in the ON position and ac power connected additional series resistor R103 is introduced in series and limit the current just enough to trickle charge the batteries. Q102 is off, thus prevent accidental battery discharge. Disconnecting ac power turns on Q102 enabling the DC to DC power supply to be driven directly from the batteries.

8-8. Installation and Replacement. Disconnect ac power cord. Remove the top cover of the instrument (refer to paragraph 5-5). Attach and secure the batteries, be careful not to reverse the polarity of the batteries. Replace the top cover. Charge and check the batteries as described in paragraphs 8-4 and 8-6.

8-9. PARALLEL BCD PRINTER OUTPUT, OPTION C

8-10. General. The BCD output option provides digital measurement information in parallel BCD format to a rear panel connector for use with digital printers, systems, limit controllers and other remote applications.

8-11. Specifications.

Type : Serial to parallel converter.

Logic : Positive true.

Form : Four-line BCD 1-2-4-8.

CMOS and L.P. TTL compatible.

"1" = +3.5V dc to 5.7V dc.

"0" = 0 to o.4V dc.

Continuous Data Output Update Command: By holding "1" state, the BCD output is updated at an internal trigger rate.

Busy Flag (Printer Inhibit): "1" state at Busy Flag output signifies BCD output in process of updating. During this interval, all Data Update commands from printer are ignored. "0" state signifies not Busy. Busy Flag internally modifiable to Ready.

Data Output Update Command: By "0" state or negative going input pulse 10us, or contact cosure to digital common. New measurements made after pulse will be displayed but will not appear at BCD outputs. Maximum allowable update command rate, two per second.

8-12. Operation

8-13. Input/Output Data. The input/output data available at the rear-panel connector J2 is listed in Table 8-1. The pin assignments and the logic level requirements are also listed.

8-14. Data Update Input. The BCD output may be updated by either a Data Update pulse or a continuous Update Command at pin 22, J2. This feature operates as the conventional "inhibit" signal. The Data Update pulse at pin 22 must be a negative going pulse having a width greater than 10 usec. Measurement data accumulated after a data update pulse is received will appear at the BCD output connector J2. The maximum allowable rate of data update is two per second.
The BCD output assembly is normally wired for continuous Data Update command. To modify for Data Update command, proceed as follows:

1. Disconnect the power cord.
2. Remove the top cover of the instrument case. Refer to paragraph 5-5.
3. Locate U9 and LK-1 (a solder link on top of the BCD board).
4. Refer to BCD schematic Figure 8-2. Unsolder the link, making sure to disconnect completely between the two halfes of the link.

5. Insert U9-74C74. (74C74 is a standard "CMOS" of the shelf device,can also be bought from your Kontron's dealer). Solder U9 from the bottom side.

6. Replace the top cover and reconnect the power cord. For Continuous Data Update operation, reverse installation procedure.

8-15. Busy Flag Output. The time period of actual updating of the BCD output at pin 2 of the BCD output connector, J2. During this period all external update pulses are locked out and therefore ignored. A signal LOW shows not Busy. A simple modification on the BCD output printed circuit board assembly permits the Busy Flag logic to be inverted and thereby used as a Ready Flag. A signal HIGH on pin 2 will then show that the BCD output is ready for update. A signal LOW indicates not Ready since the serial-to-parallel converter is being updated by the counter. To modify the Busy Flag, proceed as follows:

1. Disconnect the power cord.
2. Remove the top cover of the instrument case. Refer to paragraph 5-5.
3. Locate LK-2 (a solder link switch near U5 on the BCD output assembly).
4. Refer to the BCD schematic, Figure 8-1, and remove solder link LK-2.
5. Install solder link LK-3 to provide a Ready Flag.
6. Replace the top cover and reconnect the power cord.

8-16. BCD Output Cable. One-meter long BCD output cable with mating card edge connectors is available as an option. The cable is a 26 wire flat ribbon cable. It is unterminated so that the user may wire his own connector.

8-17. Theory of Operation. The BCD printer output option is a serial-to-parallel converter with associated control circuitry. It processes the serial output data from U-6 in the 4020/4021 into parallel BCD format. Five type D flip - flop in U1, U2, U3, U4 and U5 are the storage registers which convert digit strobes D5, D4, D3, D2 and D1, sequent strobes BO, B1, B2 and B3 and the polarity sign data.

8-18. "D" Flip-flops U1, U2, U3, U4 and U5 are strobed with the digits strobes in sequence. The "D" flip-flops are being controlled by U5A. D5 pulse enables the data input into the flip-flops and D1 pulse disables it. U1 through U5 provide buffered outputs to drive Low Power TTL or CMOS.

8-19. At time D5, which is the most significant digit, a high level on B1 will indicate over-range.

8-2o. Polarity will be indicated at D5 strobe time.

Table 8-1. Digital I/O Data at J-2

Pin No.	No. of Lines	Signal	Signal Logic		Logic Level	
			High	Low	"1"	"0"
21	1	M.S.D. (most significant digit)	1	0		
19		1	1	0		
20	4	2	2	0		
7		4	4	0	3.5 to 5.3V dc	0 to 0.4V dc
6		8	8	0		
17		1	1	0		
18	4	2	2	0		
9		4	4	0		
8		8	8	0		
12		1	1	0		
16	4	2	2	0		
11		4	4	0		
10		8	8	0		
15		1	1	0		
14	4	2	2	0		
1		4	4	0		
24		8	8	0		
5	1	Polarity	+	-		
4	11	Overrange	Over-range	-		
22	1	Busy Flag Cont.Update (Input)	Busy Update	Not Busy Inhibit	Open or 5V dc	0 to + 0.4dc or contact closure to logic common
22	1	Data Update(input)	Inhibit	pulse		
3	1	Logic Common	on	-		
13	1	Decimal Pt 1(MSD)	on	-		
25	1	Decimal Pt 2	on	-		
23	1	Decimal Pt 3	on	-		
26	1	Decimal Pt 4	on	-		

Table 3-2. PARTS LIST; BCD PRINTER OUTPUT, OPTION C

DWG. REF.	DESCRIPTION	PART No.	MFG Code	MFG Part No.
C1	1 nF Ceramic	1500-0102	90201	RMC-CCD 1 nF 100V Type TA
C2	1 nF "	1500-0102	90201	"
C3	1 nF "	1500-0102	90201	"
C4	1 nF "	1500-0102	90201	"
C5	22 nF "	1500-0223	90201	RMC-CCD 2.2 nF 100VType TA
R1	10K1/4W 5%	0100-0103	01121	CB 1035
R2	10K1/4W 5%	0100-0103	01121	CB 1035
R3	2.2K1/4 W 5%	0100-0222	01121	CB 2225
R4	2.2K1/4 W 5%	0100-0222	01121	CB 2225
R5	2.2K1/4 W 5%	0100-0222	01121	CB 2225
RN1	100K SIP	0111-0104	80294	4310-R-101-104
U1	CD4076	0520-0280	27014	CD4076
U2	CD4076	0520-0280	27014	CD4076
U3	CD4076	0520-0280	27014	CD4076
U4	CD4076	05020-0280	27014	CD4076
U5	74C74	0520-0290	27014	74C74
U6	74C00	0520-0300	27014	74C00
U7	CD7076	0520-0280	27014	CD7076
U8	CD4025	0540-0050	27014	CD4025
U9	(optional) 74C74	0520-0290	27014	74C74

Figure 8-1.

BCD Schematic Diagram

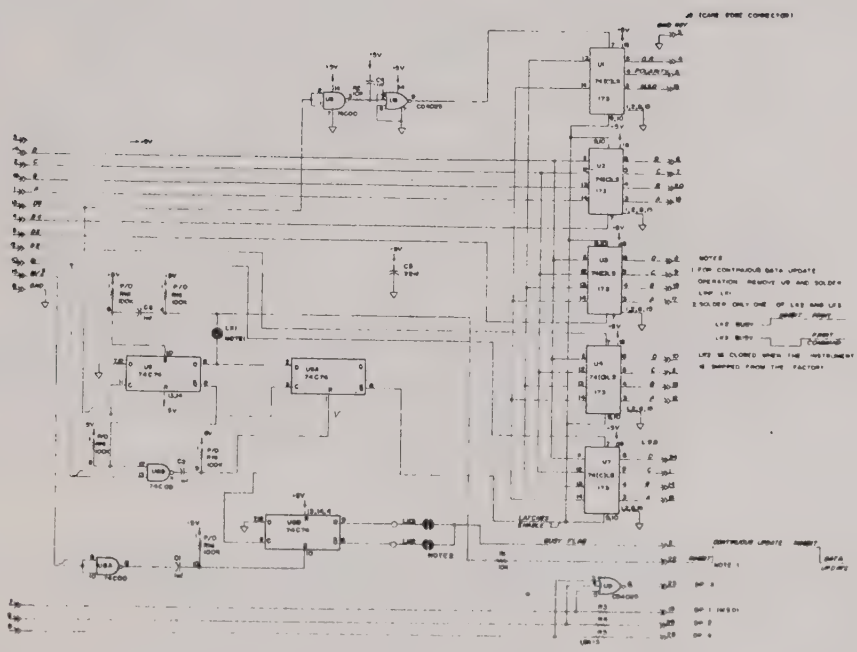


Figure 8-1. BCD SCHEMATIC DIAGRAM

Figure 8-2. BCD Output, Parts Location Diagram.

8-21. HOLD PROBE , OPTION HP

8-22. General. The Hold Probe gives a mean of "freezing" a measurement, at any instand, in places where the eyes must be kept on the circuit being measured. The Hold Probe circuit is factory installable only.

8-23. Operation. A slight push with the hold probe on the point being measured enables the internal circuitry to operate and sample the input. The moment the pressure on the Hold Probe is relieved, the display will hold the last sample. Modification for the Hold Probe includes modification of the overrange indication. Overrange will be indicated by steady 8888. No measurement above 20.000 counts can be made with a DMM modified for the Hold Probe. A schematic diagram is shown in Figure 8-3.

WARRANTY

KONTRON Electronics Inc. warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are fuses and batteries which carry the warranty of their original manufacturer where applicable. KONTRON Electronics Inc. will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned either to KONTRON Electronics Inc., 700 South Claremont St., San Mateo, Ca. 94402 or your local KONTRON Representative freight prepaid, and when examination reveals that the fault has not occurred because of misuse or abnormal conditions of operation. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. KONTRON Electronics Inc. will submit an estimate for such charges before commencing repair is so requested.

CALIBRATION CERTIFICATE

KONTRON Electronics Inc. warrants that this instrument maintains latest published specifications and that this instrument has been calibrated with secondary standards traceable to the National Bureau of Standards, U.S.A.

W. Schäfer

Walter Schaefer
Product Marketing Manager

MP MASTER
MA35127

KONTRON
ELECTRONICS, INC.
ADVANCED ELECTRONIC INSTRUMENTATION

630 Price Ave.
Redwood City, CA 94063
Tel: (415) 361-1012
Outside CA: (800) 227-8834

SE Laboratories
LOC: KK4
MAN-07791